THE

ELECTRICAL REVIEW.

VOL. LIV. JUNE 10, 1904. No. 1,385.

ELECTRICAL REVIEW.

Vol. LIV.] CONTENTS: June 10, 1904. [No. 1,385.

	Page
Recent Developments in Metal Conduits for Electric Light Installations	937
The Continuous Protection of Conductors (*illus.*)	939
Why Use Carbon Brushes on the Modern Dynamo? (*illus.*)	940
Electrical Ore Finding	941
Chilled-Iron *v.* Steel-Tired Wheels	942
Electrical Engineers at the Military Tournament	943
Our Legal Query Column	943
Parliamentary	944
Correspondence	947
The Repulsion Motor (*illus.*) (*continued*)	949
The Continental Electrical Engineering Industry	949
Legal	950
Business Notes	951
Petrol-Electric Motor Coaches on the North-Eastern Railway (*illus.*)	955
A New Electric Hauling Winch (*illus.*)	957
The Dick-Kerr High Pressure Oil Switch	957
Electricity Supply Accounts	965
City Notes	965
Stocks and Shares	966
Share List of Electrical Companies	967
Market Quotations	968
Electric Tramway and Railway Traffic Returns	968
Institution of Electrical Engineers:—	
Power Station Design (*concluded*)	969
Regulating Impedance Coils (*illus.*)	971
Automatic Protective Devices for Electrical Circuits (*illus.*) (*concluded*)	972
Internal Combustion Engines and the Diesel Principle	975
Thermal Storage	975
New Patents Applied For	976
Published Specifications	976

THE

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RECENT DEVELOPMENTS IN METAL CONDUITS FOR ELECTRIC LIGHT INSTALLATIONS.

ONE of the most remarkable features of the correspondence which has been appearing in our columns under this heading for the last two months is, perhaps, the manner in which most of those who have written have failed to keep to the point. It is true that the point in question was modestly reduced to almost geometrical proportions in his original article by Mr. L. M. Waterhouse, and that the author introduced many other statements of a contentious character; so that the temptation to go off at a tangent and debate the questions of cased *v.* conduit, of lined *v.* unlined conduit, and of socketed *v.* screwed conduit, was perhaps excusable under the circumstances. The correspondence is also remarkable for two other reasons; first, it comes in cycles whose length we have not yet determined; and secondly, like the telephone question, it always involves the introduction of personalities. The last-named effect is, no doubt, due to the fact that the conduit business, and all ideas connected with it, have been in the hands of quite a few, who naturally either have rival systems or compete in the same line. That the correspondence recurs with such vehemence at regular intervals appears to show that some idea or improvement, or some new regulation of supply, calls for a periodical reckoning up. In the present instance one fact stands out clearly, namely, the very secondary position taken up by the advocates of wood casing. There is no doubt that a large amount of casing is still used, but its relative proportion to metallic conduit is annually decreasing, for the simple reason that socketed conduit, at any rate, can be erected more cheaply, and is looked on with greater favour by the fire insurance inspectors and the supply authorities. So the chief battle rages as between socketed and screwed, and lined and unlined conduits. The duel between the last two has been fought several times in these columns, the late Mr. Bathurst having originally been the redoubtable champion for the lined conduit. Of course there is plenty of room for both qualities, and if customers prefer the lined conduit at a slightly higher cost for equal inside diameter, who shall say them nay? No doubt Mr. Waterhouse's remark that the strength of a chain is that of its weakest link, is very applicable in this case; but again, it depends largely on the care taken by the erector as to what this strength shall be. The question of condensation is of a different kind, but it appears to be fairly well established that lining a conduit does not altogether overcome the trouble. The contributor in our last issue who so largely invoked the aid of theory, started on the assumption that condensation originates on the outside of the conduit and trickles through at joints, and that therefore if joints were watertight there would be no collection of condensed water inside. He appears to forget that a

system of tubing forms an excellent conveyance for currents of air unless the ends are closed, which is almost an impossibility. We think that condensation is just as likely to take place inside as outside the conduit, and more so when the latter is buried in plaster.

The chief contest, then, lies between screwed and unscrewed conduits, the former consisting of light brazed and heavy welded or weldless. Here it is that a new fact has appeared. It is becoming increasingly apparent that metallic conduits must be efficiently earthed, and to be efficiently earthed they must be electrically continuous. The latter qualification has only been the property of screwed conduits up to the present; now Mr. Waterhouse says he can give it to socketed conduits, and thus reduce the cost of an *erected* electrically continuous system to very little more than that of an ordinary socketed system, which is less than that of wood casing.

Mr. Waterhouse does not inform us of the nature of his device, but we understand it will very shortly be on the market. In any case, if it does what he claims, it should be a useful advance in efficiency of house-wiring in conformity with modern conditions of supply. If then the circumstances are as stated, the advantages of screwed conduit are nil for the heavy gauge, and not much more for the light brazed for all ordinary work. That these classes will continue to fill a want in connection with wiring in mines, on ships, and in chemical works, &c.—places where "close-joint" conduit would be quite unsuitable—goes without saying. And we are inclined to agree with another correspondent who states that, condensation being an admitted evil common to all conduits in greater or lesser degree, for all ordinary purposes for the time that the india-rubber insulation will last, the ordinary "close-joint" conduit is as good as anything else.

Our Electricity Works Tables.

With this issue our readers will receive Part I. of our annual statistical tables relating to the electricity works of the United Kingdom. Several modifications have been made in the form of the tables, with a view to increasing their precision and utility; a number of new works have been added to the list, and the whole has been revised, with the kind assistance of the engineers of the respective undertakings. In a work of this magnitude, involving, as it does, no fewer than 12,000 separate items, it is impossible to ensure that no errors or omissions shall occur; if only one minute were devoted to each item, on the average, 200 hours' close application of an exceptionally arduous character would be necessitated, without interruption to the normal duties of the editorial staff. We trust, therefore, that if any defects are discovered in the tables, our readers will regard them with leniency, and will do us the favour to draw our attention to them. Finally, we must express our sincere appreciation of the courtesy with which our requests for information have been received by the engineers, who, as we are well aware, are so frequently called upon for this purpose nowadays, that their patience must at times be severely tried.

Part II. of the tables will appear with our issue of the 24th inst.

The L.C.C. Trams and Workmen's Fares.

Those who are in the habit of using the L.C.C. trams may have observed a handbill posted upon them lately, stating that new regulations were to be introduced governing the issue of workmen's tickets upon the early morning cars, and these have now been brought into force. Ordinary passengers pay fares from ½d. to 3d., according to length of journey; but as is usual nowadays, specially low fares are issued to artizans on their way to work, the through fare being 1d., and a return ticket—or a two-journey ticket as it should be called—2d. Hitherto, upon the early morning cars the workman, by paying a 1d. fare, has been entitled to travel the full length of the route, while his ticket acts also as a coupon, and on giving this up at any subsequent time and paying a further 1d., he becomes entitled to a second ride over the full route of any of the Council's lines, *i.e.*, the double journey costs him 2d., of which 1d. is paid on the outward, and 1d. on the return trip. The new rules modify the above regulations in two essential points. First, the 2d. return fare must be paid in advance—as upon railways and other tramways using return tickets—while secondly, the return ticket, though good upon any of the Council's lines, is available upon the day of issue only.

The reason for these alterations is that the old system has been greatly abused—and indeed it is not surprising that this should be the case. The "return coupon" issued to early morning passengers free of cost (other than the payment of their 1d. for the present ride), by entitling the holder to a 3d. journey upon payment of but 1d., becomes at once of commercial value; and it appears that sundry enterprising persons have seen the possibility of establishing a lucrative business in the purchase and sale of such tickets, and, moreover, have brought the possibility into the realms of practice. The limits to this trade have lain in the fact that passengers using a 3d. fare form but a very small proportion of the cars' patrons, and that in consequence the demand for these coupon tickets could never reach large dimensions. But, clearly, if ever the demand should exceed the supply, an additional stock might always be procured at a cost of 1d. each (or half their actual value) by rising early some morning, and boarding every car that came by, paying a 1d. fare on each, and dismounting as soon as the return coupon was secured. Or, more simply, with the aid of a friendly conductor, by getting him to issue to himself a couple of dozen or so tickets, paying for them, of course, at their face value. The new regulations, though still giving many opportunities for the ingenuity of the working man to get the better of them, will prevent any such wholesale dealing as this, since, the ticket being available on the day of issue only, there will not be time for it to change hands systematically; while the fact that the full fare must be paid in advance will tend to prevent the purchase of such tickets speculatively.

The particular point which renders the L.C.C. peculiarly liable to being "got at" in this manner, is that the workman's return ticket costs less than the single fare of an ordinary passenger; and it consequently means a saving for him, if he has to travel by an ordinary car, to rise early and take an unnecessary journey on a workmen's car in order to secure the benefit of the special tariff. Lines such as the Central London Railway, where the workman's return ticket costs the same as the ordinary single ticket, are free from this trouble, since there is no economy in purchasing a return if one half is to be wasted. On the other hand, many of the suburban railways which issue workmen's tickets at considerably less than half the ordinary rates, would undoubtedly have serious difficulty from this cause, were it not that their tickets are all named and dated, being good only in one direction and on the one day. Yet even here it is found necessary to limit each man to one cheap ticket per day, to prevent his going out for an evening's dissipation at the low fare allowed him on his journey to work.

Shock Fatality.—It is reported that a foreman electrician, while testing some wires in the New York subway tramway, received a 30,000-volt shock, and was killed.

THE CONTINUOUS PROTECTION OF CONDUCTORS.

By A WIREMAN.

Of wiring systems there are many, and each has its ardent advocates. The question of what is the most generally applicable medium for the proper enclosing of conductors has been provocative of numberless discussions and articles. In adding to these papers, one must find excuse in the fact that wiring for lighting and power purposes employs a very large proportion of our trade; and it really is important that we should find a better system than most of us have hitherto used.

Wood casing has deservedly held a high place in the opinion of many electricians. For certain places and conditions, it can hardly be improved upon, but everyone admits that it is often unsuitable.

Lead covering is so marvellously easy to install that it has appealed to most on that account, but many and various are the ills attending its use. The liability to corrosion by the formation of lead acetate, with its rapidly spreading and pitting effects, is not the least of the inconveniences met with in practice.

Wrought-iron tube of good stout gauge, and with its interior well rodded, has long had many users. Whether enamelled or not, it outlasts the paper-gauge steel tubes which are being urged on the attention of the electrical contractor. When such an iron tube is carefully screwed and fitted, it is in "for good." In cities, almost every new

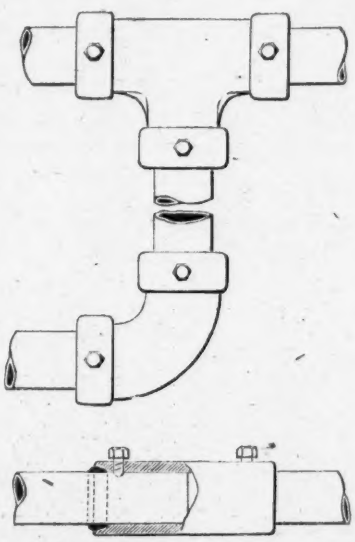


Fig. 1.

building has to be wired, and in most cases it is a necessity that tube be used, even if only to protect the conductors from the workmen who finish the building. The greatest disadvantages are the comparative high costs of erection and the damage which a careless or unskilled wireman may do when fitting it in.

Contractors who have hitherto used screwed tube find that a large proportion of the unprofitable outlay goes in the purchase and upkeep of screwing gear, and on the various jobs themselves a great deal of time is lost by men travelling to and from the screwing bench. With screwed tube it is a very careful man indeed, who removes all the sharp metal turnings which fall into the interior and remain stuck in the film of oil which gets inside when the tube is being screwed. He sometimes cleans out the ends just as far as his little finger will reach, but further in there always remains the harmful deposit to menace the conductor insulation. And he will often give the tube a final twist into its socket with harmful effect to the contained conductor. These are the disadvantages peculiar to all screwed metal conduits, but they are slight compared to those from which most other systems suffer. These drawbacks, however, have been got rid of successfully, by the introduction of screwed stud fittings. Examples of coupling tee and bend are shown in fig. 1. These seem to retain all the advantages of ordinary screwed methods and to have several others. The contractor using these requires no screwing machinery and has no waste time in screwing.

The couplings and fittings have contact studs whose hardened steel points penetrate into the bright metal of the tube, and while making a thoroughly mechanically strong joint, also ensure lasting electrical continuity. This method of making contact with a screwed pin is that generally adopted on lampholder, switch, and fuse, so there is no doubt about its conducting efficiency.

The mechanical strength of unscrewed tube is, of course, much greater at the joints than ordinary screwed material, as the diameter is not reduced by twice the depth of an external thread.

In addition to mechanical and electrical advantages, and low cost of erection, great economies can be made by having the branch and sub-main boxes with outlet holes of the same

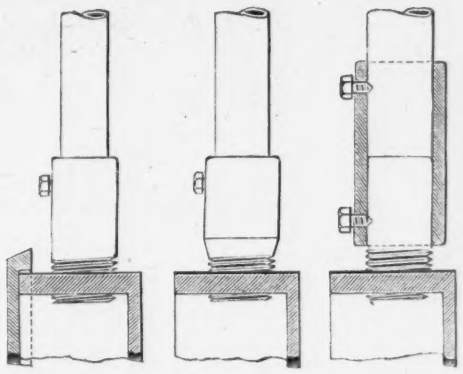


Fig. 2.

size. For all branch wires and for most sub-mains the sizes of the tube are $\frac{1}{2}$ in., $\frac{5}{8}$ in., and $\frac{3}{4}$ in. external diameter, and stud couplings are made so that if the junction, tee and terminal boxes have $\frac{3}{4}$-in. tapped holes, then they are suitable for all the above three sizes of tube.

Fig. 2 shows the form of connector to adapt the different sizes to $\frac{3}{4}$-in. bored boxes. The top coupling is for $\frac{1}{2}$-in. tube, the middle one for $\frac{5}{8}$-in. tube, and the bottom one for $\frac{3}{4}$-in. tube, the latter being used in conjunction with the standard two-stud coupling.

Of course the tube can be used in connection with boxes screwed to the actual size of tube used, or the boxes can be had with projections bored for the various tubes and fitted with studs in the same manner as the straight couplings illustrated. Boxes with plain unscrewed projections can be used, but are not recommended owing to the trouble of efficiently bonding them across.

For the majority of positions, only two sizes of junction and terminal boxes are required. One small square box measuring $2\frac{1}{2}$ in. × $2\frac{1}{2}$ in. × $1\frac{1}{2}$ in. deep inside with a single-tapped hole on each side is convenient for four-way, three-way, and even for switch and ceiling rose terminal boxes. The unused holes can be neatly plugged with metal or hard wood stoppers. The other most generally applicable size measures $2\frac{1}{2}$ in. × 6 in. × $1\frac{1}{2}$ in. deep with six holes, and is handy for distributing or two switch positions. Neat patterns with screwed down lids really bored and tapped can now be had from most ironfounders at very cheap rates. Certainly it is better in a number of cases to have a supply of boxes with only one or two holes; but as described the variety of position to which these sizes are adaptable is very great in either sunk or surface work. For switches for pendant and bracket boxes, the usual iron lid is replaced by a neat hardwood block on to which the brass plate or switch is in turn screwed.

D

With regard to the advisability of making a tube system watertight, there is room for great difference of opinion. Tubes exposed to water vapour, and on damp walls, or underground, should admittedly be watertight. As for ordinary indoor work, however, any water trouble that may arise is generally due to condensation inside the tube when the surface is exposed to variable temperatures. For positions in which it is desirable to make the screwed stud system thoroughly watertight, couplings and fittings are supplied with a recess for red lead or other paste, as shown in the section of straight coupling in fig. 1. It will be noticed that the paste does not come into contact with the screwed stud on which the electrical continuity largely depends; so there is a clear and clean metallic connection throughout the entire system, and the conducting properties of the conduit are not interfered with by intervening films of paste, such as are present between all the coupling and tube ends in ordinary screwed watertight work. Several steel tubing systems have couplings fitted with jamb or split nuts which are designed to hold the tube by compression. Many of the benefits of screwless tube are so obtained. But one cannot be sure of the workmen carefully removing the enamel from the tube ends and from the interior of couplings at each joint, and, if this is not done, the system cannot be an earthed one at all.

These screw stud fittings are, of course, patented, and the rights are held by Messrs. Stewarts & Lloyds, who issue them for use in connection with their specially ductile reamed and rodded electrical tubing.

WHY USE CARBON BRUSHES ON THE MODERN DYNAMO?

By J. W. BURLEIGH.

Considering present-day knowledge of dynamo design, is it not a matter of wonderment that the carbon brush is used to the large extent it is? The enormous commutators

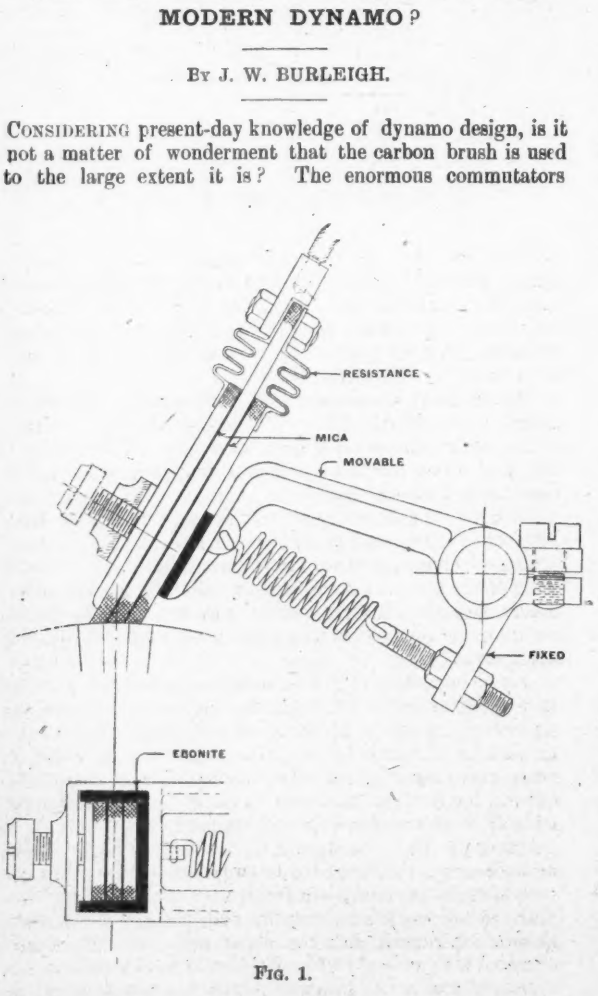


Fig. 1.

required, the extra expense of brush gear, larger shafts, and longer machines, must increase the cost of production (compared with metal brushes) by a large amount. Especially is this the case when large currents have to be dealt with. To be plain in the matter, the designer is doubtful of the efficacy of metal brushes; the result is, he prefers to use a "fakement" in the form of carbon. This "fakement," especially in low-voltage dynamos, presents an extremely expensive remedy for commutation troubles. Not only must we think of the increased prime cost, but also bear in mind the loss of efficiency; in fact, it frequently happens that one could increase the commercial efficiency of a machine 2 or

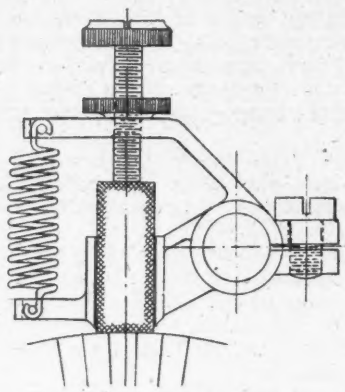


Fig. 2.

even 3 per cent. by using metal brushes. Yet, generally speaking, consulting engineers clamour for carbon brushes and high efficiencies, unmindful, it seems, of the fact that carbon brushes are not conducive to high efficiency. The writer fails to see why the brush material should be specified at all—there certainly can be no objection to the use of metal brushes, if by their use one can secure sparkless commutation with fixed brush position.

For the purpose of comparison, let us consider the design of a commutator (with both metal and carbon brushes) for a six-pole machine with parallel-wound armature. Output 110 volts 800 amperes at 450 r.p.m. Neglecting shunt current, the amperes per row of brushes $= \frac{800}{3} = 266{\cdot}7$ amperes.

	Carbon brushes.	Metal brushes.
Number of brushes	9	3
Size of brush	$1\frac{1}{2}'' \times \frac{3}{4}''$	$1\frac{3}{4}'' \times \frac{9}{16}''$
Area of contact	1·125 sq. in.	982 sq in.
Area of contact per row ...	10·1 sq. in.	2·95 sq. in.
Diameter of commutator	17 in.	17 in.
Peripheral speed	2,005	2,005
Coefficient of friction	·3	·2
Watts lost by friction (a)	1,025	205
Area of + brushes	30·3 sq. in.	8·85 sq. in.
Amperes per sq. in.	26·4	90·3
Resistance per sq. in. (contact) ...	·03	·003
Contact watt loss (b)	1,260	434
Total loss ($a + b$)	2,285	639
Length of commutator	17 in.	6 in.
Radiating surface	910	320
Watts lost per sq. in.	2·51	2·0
Commercial efficiency with carbon brushes,	91·8 per cent.	
" " metal "	93·4 "	

It will be seen from the above example that not only could we have saved quite 12 in. in length (for temperature rise to be same in both cases), but we get our efficiency increased by 1·6 per cent. Nor must we omit to take into consideration the mechanical construction of the commutator, as, of course, it would be far more difficult to construct with a bar 17 in. long than with one of 6 in.

It is well known that the chief virtue of the carbon brush is its high specific resistance, which greatly facilitates sparkless collection. Carbon brushes are also well adapted for reversible motors, owing mostly to the ease of designing a carbon holder, which is suitable to either direction of rotation of commutator.

For successful collection with metal brushes, using a width approaching that used for carbon, it is necessary to sub-divide the brush and to place an insulating partition between each portion, also to insulate the containing case. The extreme ends should preferably be connected with a

metal of high specific resistance to prevent a flow from "toe" to "heel"—in fact, to a certain extent, to throttle wasteful currents in the short-circuited coils. By careful design it is, in the writer's opinion, feasible to secure the main advantages of the carbon brush without its disadvantages. The design shown in fig. 1 represents the type of sub-divided brush favoured by the writer. If, however, it is desired to have a reversible machine, there is

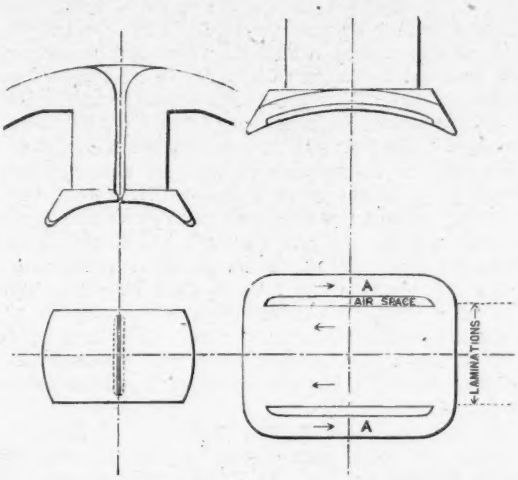


Fig. 3.

Fig. 4.

no help for it but to use a butt brush. Possibly a brush constructed on the principle shown in fig. 2 would prove satisfactory—it will be observed that by slight modification, this holder could be made suitable for a sub-divided brush.

The most important matter, however, to be considered when substituting metal for carbon brushes, is undoubtedly the design of the pole-pieces. Various schemes have, from time to time, been proposed for throttling the cross flux. Slotting the poles parallel to axis of shaft seems at first sight a rational method of reducing distortion, but, from practice, it appears that the reduction is not nearly as much as might be anticipated. Several designs, too, which have been used, should

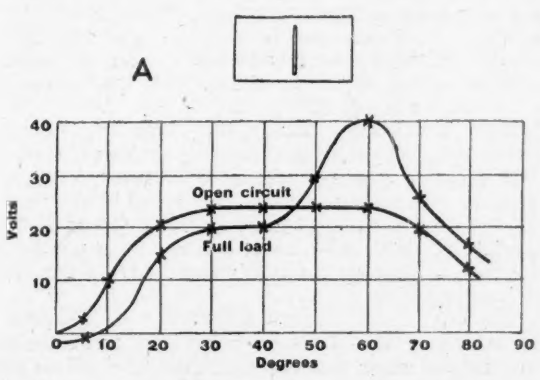


Fig. 5A.

produce a good commutating fringe. Probably a design as shown in fig. 3, with a slot cut from pole face right through the yoke, and with the shoe having rounded ends, would represent a typical form which has been used in the past with fairly good success, but this design is not altogether what would be required for use with metal brushes. Fig. 4 represents a pole-piece designed by the writer (referred to in an article in Electrical Review, December 5th, 1902); it will be seen that a very simple method is used to strengthen the weakened horn. A A represent connecting pieces of magnetic material, which lie outside the influence of armature reaction, and in contact only at the horns, thus rendering the magnetic potential at one pole tip equal, or nearly equal, to the other. The result is a much greater reversing field than is obtained from other pole-shoes. Figs. 5 show potential wave curves taken from a four-pole dynamo with ordinary pole shoes (A), and with the writer's equalising pole (B). These curves illustrate, in a remarkable manner, the great advantage derived from the use of an equalising pole. It will be apparent that there is no appreciable increase in

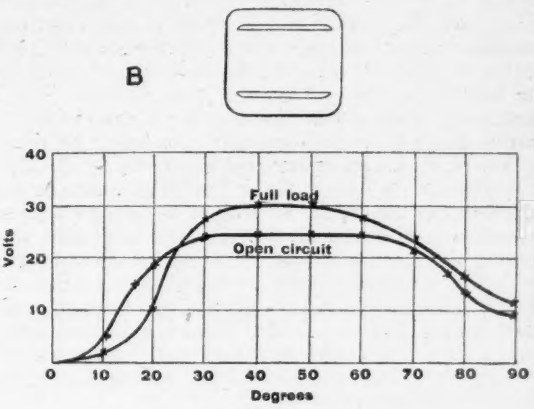


Fig 5B.

cost by using an equalising pole, nor does it in any way detract from the appearance of a machine.

In conclusion, the writer thinks it would not be too much to say that the use of carbon brushes will, in the course of a few years, be practically abandoned, and metal brushes will be again used, no doubt in a different form to that used in the past, and probably constructed on the basis of designs shown in this article. No doubt, however, improvements in the design of pole-pieces will do more than anything else towards making the use of metal brushes general.

ELECTRICAL ORE FINDING.

On Monday last, at the Westminster Palace Hotel, a demonstration of the Daft-Williams ore-finding apparatus took place, under the auspices of the Electrical Ore-Finding Co., Ltd.; the chairman of the company, Mr. Andrew Anderson, took the chair, and there was a large attendance of electrical engineers and others.

The proceedings commenced with the reading of a paper on the system by Mr. Alfred Williams, in which he outlined the history of the subject, and instanced a number of successful prospects carried out with the apparatus in various parts of the world. As we fully described the system in our issue of April 3rd last year, we need not again dwell upon it at length; suffice it to say, that by means of an apparatus involving the use of high pressures, obtained by means of an induction coil and spark gap, electrical impulses are transmitted into the earth, and the distribution of the resulting waves is explored with the aid of a telephone receiver, the terminals of which are connected with two electrodes which are stuck into the ground at a suitable distance apart. The varying intensity of the sounds heard in the receiver, depending upon the conductivities of the underlying strata, and strongly affected by the presence of mineral lodes or veins, whose conductivity differs materially from that of the surrounding soil, affords a clue to the direction, depth, and, it is said, even the character, of such lodes.

Following Mr. Williams, Dr. S. P. Thompson, whose presence on the platform naturally gave the proceedings an importance which might otherwise have been lacking, discussed the system from a scientific standpoint, and described his own experiences with the apparatus. Dr. Thompson expressed his approval of Mr. Williams's modest claims for the capabilities of the apparatus, which was not supposed to work miracles. After briefly describing the principles of the system, he reminded the audience that electricity does not travel solely by the path of least resistance, but by every possible path. The presence of ore lodes distorted the electrical

field, even when they were of a non-conducting character, such as quartz reefs. It was quite certain, said Dr. Thompson, that when there were well defined lines of ore underground, they could be localised by means of that apparatus.

He had been very sceptical at first as to the practicability of the system, but had personally explored a rocky hillside in Wales, where lodes of galena were being worked, and had himself traced the course of a lode; he was now quite convinced that the method was applicable to galena and other conducting ores, but could not say whether it would prove useful in gold mining. He was anxious not to overrate its capabilities, but he believed that it would do good service in tracing the direction of known lodes, and would effect great savings generally in exploring for ore.

Mr. W. P. J. Fawcus described the results obtained with the apparatus on his property in Cumberland. Not only had the inventors mapped out veins of ore which were known to exist in a certain area, but Mr. Williams, in tracking a lode of lead ore from the outcrop, discovered two unknown veins, which he identified as copper ore, and it was subsequently found that these veins were recorded in old maps, but had been totally forgotten. Mr. Fawcus also described the upshot of a sweepstakes depending upon the localisation of a water pipe, which was accomplished by several explorers to a fraction of an inch.

A practical demonstration followed with a box of soil, "salted" with quartz, lead pipe, &c., and presumably intended for the edification of the lay Press and members of the Stock Exchange; too much importance need not be attached to the results of the search for these, which was, no doubt, completely successful.

CHILLED-IRON v. STEEL-TIRED WHEELS

There are still two sides to the wheel question. Latterly there has been a lull in a controversy, which was begun rather too soon for the champions of steel tires, who had very few guns cast in the foundry of practice to train on their opponents. In the meantime they have not been idle in their winter quarters, and, indeed, appear to have raided certain of the weaker strongholds with a success more or less complete.

It will be well for us, therefore, to examine the position and prospects of the combatants from a neutral height, if it is possible to see anything distinctly in the presence of so much dust.

In the first place, let us see what there is in the way of written testimony.

Mr. R. H. Simpson, writing in the *Street Railway and Tramway Journal*, thinks that if steel and iron wheels are compared under exactly similar conditions, there will not be much difference in the eventual cost per car-mile. His detailed comparison of costs is the fairest in intention, and the soundest in design yet seen, and it is evident that he is an unbiassed witness. He takes out the cost over four years, and finds the steel tire with £4 2s. to the good at the end of that time. The calculations are based on a life of 30,000 miles for the chilled, and 60,000 miles for the steel wheel, 120,000 miles being run by each in the four years. The saving is equivalent to ·0082d. per wheel-mile, but this is obtained by omitting to allow for depreciation on the centres. If 5 per cent. per annum is written off on this account (and we do not think that 20 years is an immoderately short life for such parts), the value at the end of four years will be £6 8s., and the steel wheels will have cost £19 12s., against £22 2s. for the chilled wheels. This is equivalent to a saving of ·0012d. per wheel-mile.

Sheffield turned from chilled to steel wheels in 1900, and the reasons were given by Mr. Fell in the *Light Railway and Tramway Journal* of June, 1902. Chilled wheels rarely ran more than 20,000, the average being much below; while at the date of the article, although no steel-tired wheels had worn out, observations indicated a life of 5,000 miles per ½-in. depth of tire, making the useful life 60,000 miles.

Mr. Fell gave a comparison of the cost of the two classes of wheel, which is misleading if any attempt is made to apply the figures to the general proposition. The comparison appears to do its best for chilled wheels, but ends with a balance of £8 per 60,000 miles (·003d. per wheel-mile) to the credit of steel tires. A reply to this article, from a knight of the other camp, appeared in the form of a letter in the September issue of the same journal. Therein the balance against chilled wheels was converted into surpluses of £5 16s. (·0023d. per wheel-mile), or £11 14s. (·0047d. per wheel-mile), according as Mr. Fell's or the writer's premisses are accepted. As both are obviously inaccurate, we think that both arguments should mutually cancel for the purpose of an unbiassed review.

In the April, 1904, issue of the *Street Railway Review* (European edition) begins a symposium on the subject, to which nine gentlemen contribute. The opinions expressed have been condensed to such a degree that it is hardly possible to reduce them further and keep them intelligible.

The Portsmouth engineer puts himself out of court by showing a balance of £11 16s. per 70,000 miles (·04d. per wheel-mile) in favour of steel tires, by means of taking 23,000 miles as the average life of C.I. wheels, and by assuming 70,000 miles life for steel tires, without any allowance for turning. We take his word that his chilled wheels have averaged only 23,000 miles, but that is merely evidence of bad local conditions, as we shall show hereafter; and in the face of this proof of imperfection, the assumption of the maximum possible life for steel wheels which have not been in service more than one-quarter of that maximum life (so we gather from Mr. Lironi's remarks) is unwarrantable, and the figures must be rejected.

Mr. Street, of Southampton, thinks steel tires better for the rails, and often more directly economical than chilled wheels, but does not back his opinion with figures. That opinion, however, is valuable, as it has been formed after much experience in America where the steel wheel is almost unknown.

Dublin, Newcastle, Liverpool, Norwich and Bradford, are all experimenting with steel tires; Wolverhampton intends to stick to chilled, while Cardiff is about to try them for the first time against steel tires, which so far have been quite satisfactory.

Dublin and Bradford have got only 20,000 to 22,000 miles out of chilled wheels, against 33,500 per wheel in Liverpool, and 28,000 in Wolverhampton.

Sixty thousand miles has been reached by chilled wheels on the Belgrano and Buenos Ayres lines, *and the average wheel mileage has increased 35 per cent. through careful instruction of motormen.*

America favours the chilled wheel for tramway service almost wholly, and the greater part of the freight wagons on the railways are equipped with them; but there is a strong tendency to put more trust in steel wheels for high speeds, so that inter-urbans are found often running the latter, a tendency which is sure to increase from the fact that the Committee on Standards appointed by the American Street Railway Association in 1901, said: "With a view to safety and economy, we recommend for motor-cars used in suburban and interurban service, a steel-tired wheel" of a certain section. The recommendation was adopted by the Association at their Detroit meeting in 1902 (*Street Railway Review*, November 20th, 1902). It is implied tacitly that for the comparatively low-speed urban service chilled wheels are good enough.

The mileage per ½ in. radial depth of tire varies as much as everything else which works under various conditions. One English maker writes within the last few weeks of 5,000 miles being the latest available record, while another claims 6,500 as the *lowest* recorded result (*Light Railway and Tramway Journal* for January, 1904), and the Indiana Union Traction Co. record 13,000 miles, not including turning down. The latest figure is quite useless for application to English conditions, and for purposes of comparison we should take Mr. Simpson's figures of 30,000 and 60,000 for chilled and steel wheels respectively as safe averages for life under decent conditions.

For seekers after light on this obscured matter, we recommend an article entitled "Street Railway Wheels in Europe" (*Street Railway Journal*, December, 1902), which gives a good general view of practice on the Continent.

In Brussels, steel tires which make an average life of 40,500 miles have replaced chilled wheels, "which rarely ran as much as 37,300 miles." As the cost per 1,000 km. is stated to be 63 centimes for the tire and two turnings, the

cost per 120,000 miles would be £25 10s., excluding the cost of taking the wheels from the car and putting them in again, and of renewing the tires. This compares very unfavourably with Mr. Simpson's £18, and we cannot see what advantage could have been gained by making the change.

On the other hand, chilled wheels replaced steel wheels on the Buda underground and surface lines, and on the Rouen tramways. In the first city, on the underground system, steel wheels ran 74,500 miles with two turnings, while up to the time of writing the highest mileage got from chilled wheels was 80,000, and 24 had run 62,000 miles, but none had yet worn out. On the tramways, chilled wheels have been very satisfactory, the average of a number running to 75,000 miles, while the whole of the worn-out wheels averaged 31,000 miles.

In the latter city chilled wheels replaced steel wheels because of the rapid flange wear.

In Milan chilled wheels average 33,800 with one grinding.

The facts we have given above make it very evident that enormous variations occur in practice, and that it is quite impossible to say whether chilled or steel wheels will be the more satisfactory, or why they are unsatisfactory in any given place, unless the whole of the vital conditions are known. That is to say, it would be more than rash to attempt to prove, as many have done, that one type or the other is the better throughout.

Certainly the pendulum of fashion seems to be swinging towards steel tires, and it may be that the better type is winning, but while chilled wheels have given much trouble in many places, it is evident that, either through insufficient experience of steel tires or through a certain lack of scientific instinct in carrying out and obtaining results from the comparative trials, there is not enough evidence on the one side at least to enable a judicious general statement to be formulated.

One good reason for the great difficulty in arriving at uniform results is given by the writer of "Street Railway Wheels in Europe" mentioned above, who introduces composite drawings showing 20 different rail-heads and wheel-treads in use in different European countries, but mostly in England. No one can wonder, after glancing at this graphic exhibition of unstandardisation, that exactly opposite results are obtained with the two classes of wheel in neighbouring towns. If general heed is paid to the voice of our Committee on Standards, future years will see more uniformity both in designs and results.

We are not bound in any way to either class of wheel, and although we have met those who have considerable trouble with chilled wheels, we confess to hoping that they will continue to be used for urban or low speed traffic, solely because, other things being equal, we should always incline to the simpler construction or mechanism, whatever it might be. It must be admitted that the liability to fracture is infinitely less with the steel-tired than with the chilled-iron wheel, and while fractures are few, and their consequences trivial when cars are running at average speeds not exceeding 10 miles per hour on paved track, we should not consider ourselves inconsistent if we advocated chilled wheels for such service, and tired wheels for higher speeds and ballasted track; for even though an economy might be effected by the use of chilled wheels at all speeds, the increased risk at the higher speeds would put them outside competition.

(*To be concluded.*)

ELECTRICAL ENGINEERS AT THE MILITARY TOURNAMENT.

At the Royal Military Tournament last Friday evening, a gala performance was given in the presence of the Duke and Duchess of Connaught, Prince Arthur, and the Princesses Margaret and Patricia of Connaught. During the evening a most excellent military tattoo was performed by the massed bands of the Guards, while the troopers of the Royal Horse Guards acted as torchbearers. The superb spectacular effect of the whole scene was, however, in a great measure due to the efforts of a small party of the Corps of Electrical Engineers. After "lights out" had been sounded, lights were lowered, and two powerful searchlight projectors threw various coloured rays of light across the arena, making a gorgeous picture of the massed bands of the brigade of Guards and their escort. During this part of the performance no less than 450 soldiers, comprising bandsmen and torchbearers, were illuminated at one time by the wedge-shaped beams of the searchlights. The projectors used were those which accompanied the Electrical Volunteers to South Africa during the late war, where they rendered invaluable service in various ways.

The preparations for illuminating this novel performance were not extensive. Under the able direction of Capt. Dumble, R.E., and Capt. Phillips, the portable South African projectors were placed in position at each end of the Hall, and coloured screens were hastily adapted to suit the new circumstances.

At the present time this corps, which is about 700 strong, is commanded by Col. Crompton, C.B., and is mainly composed of highly trained men who are experts in the various branches of electrical and mechanical engineering. Over 300 members went to South Africa during the war, where, as our readers will remember, they were of the greatest possible service to the military authorities, so that their success at the Royal Military Tournament is hardly surprising.

Thanks for this most brilliant performance are due to the management of the Gaiety Theatre, who kindly allowed Quartermaster-Sergeant Applebee to assist Captain Phillips, and to Sergeant-Major Gunn, who also rendered valuable aid.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Hoeton" writes:—"Jones & Co. are a firm of engineers whose works are electrically driven. Jones's electrical engineer has designed a switchboard to control the generating plant. This enables any circuit to be plugged either to Jones's own private bus-bars or on to the corporation's. Jones's plant generates at 230 volts, and we have a corporation service of 460 volts, and when Jones's circuits are plugged to the corporation, the circuits are balanced, one on the positive and neutral, and one on the negative and neutral, &c. On the drawings of the board being submitted to the corporation engineer, he raises the objection that the 460-volt parts are not 6 ft. apart, and, on the ground that the Board of Trade will object, refuses to pass the design and connect Jones on.

"Has he any right to refuse supply under these objections? I may say that at present there are plenty of places in Jones's and other works where these conditions are not fulfilled. The board is always operated by experienced operators, and these are the only objections he raises. Jones's bus-bars and the corporation's are entirely separate, and the circuits when plugged to the corporation bars are arranged thus: the positive of one is connected to the corporation positive, and the negative to the neutral, and in the next circuit the positive to the neutral, and the negative to the corporation negative."

*** There does not appear to be anything in the Electric Lighting Acts which gives the undertakers the right to refuse a supply on the ground that the consumers are not complying with the Board of Trade requirements. By Sec. 18 of the Act of 1882, undertakers are not entitled to prescribe any special form of lamp or burner to be used by any company or person, or in any way to control or interfere with the manner in which electricity supplied by them under the Act or any license, order, or special Act is used. At the same time, no consumer is entitled to use electricity in a manner likely to interfere with the supply in the district, and by regulations made under the Acts by the Board of Trade "the undertakers shall be responsible for all electric lines, fittings or apparatus belonging to them, or under their control, which may be on a consumer's premises, being maintained in a safe condition, and in all respects fit for supplying energy." In these circumstances, if it is true that the Board of Trade have made a rule that 460-volt parts shall be 6 ft. apart, it is not unreasonable for the Corporation to object to give a supply until this condition is complied with. At the same time, if the question suggested by "Hoeton" were brought before the Court, it is doubtful whether the objection raised would be a sufficient answer to a claim by the firm of Jones & Co. for a supply of electricity from the Corporation.

"Meter" writes:—"Assuming an electric light consumer's meter is found to be reading fast, and that particular meter has been installed on his premises for, say, five years, in what position does the undertaker stand in law with regard to this meter; that is to say, would the undertakers be bound to refund the extra amount which the consumer had been charged, owing to the meter being fast for only one quarter, or would he be liable for the whole period the meter had been installed? It is, of course, understood that the accounts are rendered and paid quarterly."

*** Apart altogether from the Electric Lighting Acts, it is conceived that a consumer who has been paying an excess of rent owing to the inaccuracy of a meter would be entitled to recover the amount overpaid to the company as money had and received by them *to his use*. Such right would not, however, enable him to

recover sums so overpaid beyond a period of six years. It seems, however, that the position of the consumer is made still more secure by the various Acts which have been passed. It is true that the Electric Lighting (Clauses) Act, 1899, provides that the consumer shall at all times, at his own expense, keep all meters belonging to him, whereby the value of the supply is to be ascertained, in proper order for correctly registering that value, and in default of his so doing the undertakers may cease to supply energy through the meter. This might seem to imply that he is liable if the meter is inaccurate. Another clause in the same Act, however, clearly implies that the undertakers may be liable in any case. Thus it is provided that if any difference arises between any consumer and the undertakers as to whether any meter, whereby the value of the supply is ascertained (whether belonging to the consumer or the undertakers), is or is not in proper order for correctly registering that value, or as to whether that value has been correctly registered in any case by any meter, the difference may be determined, on the application of either party, by an electric inspector. It may be noticed, however, that in the absence of fraud, the register of the meter is conclusive evidence of the value of the supply.

PARLIAMENTARY.

Royal Commission on London Traffic.

The Royal Commission on London Traffic resumed its sittings on Thursday last week, when the first witness called was Sir Homewood Crawford, the City solicitor. He dealt generally with the traffic problem as it affected the City, and said that, as the local authority, under the Tramways Act of 1870, the Corporation had always resisted the introduction of tramways within the City, and in the public interest, it was of the greatest importance that that position should be maintained. The City was really a huge terminus, rather than a mere highway for through traffic. In the promotion of Bills for tube railways within the City, the Corporation required clauses to be inserted providing for the work being done under the supervision of the City engineer. Care was also taken to prevent, so far as was possible, obstruction to traffic by the use of ventilators for underground railways, and attempts had been made by the Corporation to procure the removal of the one in Queen Victoria Street, the superstructure of which would, as the result of a recent Parliamentary decision, be removed so soon as the electrification of the District Railway was completed. Referring to the obstruction caused by the opening of streets by the Post Office authorities and electric light and other companies, witness said that clauses dealing with the matter were inserted in the City of London Streets Bill, 1902, but were lost, mainly owing to the opposition of the electric light, gas, and water companies. The matter was still on an unsatisfactory footing, and was liable at any time to lead to further litigation. He was of opinion that the Corporation should have full power to deal with the question.

Mr. Abraham Charles Ellis, the general manager of the Metropolitan Railway Co., was then called. Having outlined the history of the company, he said that the line was essentially a passenger line; since its opening in 1863 it had carried 2,649,263,604 passengers. Witness then described the work of electrification which is now being carried out. The equipment necessitated very considerable alterations in the permanent way, and the work had to be carried out without causing any disturbance of traffic. The difficulties were far greater than would be the case of a new electric railway. The company's generating station had been built on land at Neasden, adjoining their engineering works. The machinery was now being erected, and a considerable portion of it was complete, and in order. The station would be the most extensive in the kingdom owned by a single railway company, the main building, which covered an area of 3,570 sq. yds., being 318 ft. long × 101 ft. wide. In the engine room there were three large turbo-polyphase alternators being erected, each having a capacity of 3,500 kw., equal to about 14,000 h.p., and capable of supplying 17,000 h.p. to the track during periods of heavy traffic. Provision had been made for the erection of extensive units to meet further demands for electrical power, and probably a fourth unit would be installed at once. The steam for driving the turbo-alternators was supplied by 10 large tubular boilers, each having a capacity to evaporate 20,000 lbs. of water per hour to a steam pressure of 180 lbs. per sq. in., and also superheated to a total temperature of 250° F. The three-phase alternators would generate directly 11,000 volts across each phase, and at this voltage the current would be transmitted by three-core armoured cables to nine sub-stations on the railway. At the sub-stations the high-voltage current would be transformed by static transformers to 440 volts, a suitable voltage for the rotary converters, which would convert the alternating current to 600 volts continuous current for traction. Positive and negative conductor rails would be used, both being efficiently insulated. The new rolling stock would be entirely of English manufacture. Some had already been constructed, and was now at the works at Neasden, while some was being built at Birmingham and Manchester. The carriages would be of the open corridor type, each 52½ ft. long and 8 ft. 9 in. wide, with transverse and longitudinal seats. Plans and particulars of the cars had been submitted to the Board of Trade, though, as their approval was not obligatory, no formal sanction could be obtained. So far as possible the cars would be fireproof, and all precautions would be taken with regard to the electrical apparatus to guard against fire. From the rail level to the waist of the cars the construction would be entirely of metal. There would be an iron floor, covered with asbestos and matting or other material rendered non-flammable. The under-frame, seats and seat supports would be of steel, and the covering of the seats and the blinds would also be rendered non-flammable. The roof board would be of asbestos millboard. The cars would be encased in steel to the light bottom rail, and a minimum amount of timber would be used in their construction. In the motor-cars the cables would all be carried in Calmon's asbestos slate casings, and no power cables would be carried through the trailer cars. It was proposed to make up trains of six cars, with motor-cars at each end, the combined motors having a normal capacity of 1,200 h.p., and being worked in series and controlled from either end of the train. Westinghouse automatic brakes would be fitted to the cars. The cars would be of two classes, the one differing from the other only in the interior decoration and upholstery. The carrying capacity of that part of the railway to be worked electrically would be increased by 39 per cent. with the service at first proposed. The company were expending over electrification about £1,250,000, which included the power house, machinery and all equipment. That sum would be increased, however, if, as was contemplated, further machinery for which the power house building had been constructed, was ordered. With the advent of electric traction, the atmosphere in the tunnels would be pure and free from any peculiar odours. As now constructed, the railway had numerous open spaces in its course, and in the tunnel sections very many ventilating shafts and holes existed. The stations would be well lighted, and travel underground would, under the new conditions, be undertaken with a greater degree of comfort than existed at present on any railway below the surface. The Metropolitan Railway Co. had undertaken a very large expenditure at the instance of Parliament, and for the benefit of the public, and he suggested that it would be well to see the result of the work, and to test the carrying capacity of the railway under the new conditions, before further schemes for railways in immediate proximity were authorised.

On Friday Mr. Speyer, of Speyer Brothers, the bankers, gave evidence. He desired to reply to certain allegations made before the Commission in the evidence given on behalf of the London County Council. The firms with which he was connected, Messrs. Speyer Bros., Messrs. Speyer & Co., of New York, and L. Speyer Ellissen, were identified with the following tube lines:—The Baker Street and Waterloo, the Charing Cross, Euston and Hampstead, the Great Northern, Piccadilly and Brompton, and the Edgware and Hampstead. The total share and loan capital authorised for the several enterprises obtained by Acts of Parliament, granted during a period of 10 years—from 1893 to 1903—amounted to £16,193,000, which represented about £700,000 per mile (if the Edgware and Hampstead line—which was only partly a tube line—was omitted). That capitalisation, so far from being excessive, was, he thought, very reasonable. The only similar enterprise with which their lines could be fairly compared was the Central London Railway, the capital of which was £4,200,000, for about 6½ miles of railway, or about £650,000 per mile. He did not see why a capitalisation equal to or even higher than the Central London should be considered excessive, especially when it was remembered that the Underground Co. had to perform duties and obligations in connection with the construction of their lines, which were not required when the Central London was built. There were the expensive connections at King's Cross, St. Pancras, Euston, Baker Street, Marylebone (Great Central), Paddington, Charing Cross, and Waterloo Stations, and there was also the large expenditure on subways. The purchase of land and easements for station sites at points like Piccadilly Circus, Holborn, Hyde Park Corner, Charing Cross, and Trafalgar Square, had necessitated a large outlay. While the Underground had had to pay large sums for the land for their important stations, the Central London, he believed, had to purchase no land for their great Bank station. Had that company been obliged to purchase a site at that point for a surface station, such as the Underground were constructing at Piccadilly Circus, it would probably have added at least £600,000 to their capital, and increased the cost £90,000 per mile. There had also been additional cost to the Underground Co. in the precautions taken against fire. Witness then went on to deal with the raising of the capital, which had been done under most unfavourable conditions. Americans had been asked to join in subscribing for it, not from choice, but from necessity. The formation of the company was a simple business transaction, fair to all concerned, and nothing was paid for promotion or goodwill in the properties taken over. The London County Council, who criticised the fact that the company had not forecast precisely the cost of the railways, ought to have known how difficult it was to make such estimates with accuracy, as was shown in the case of the L.C.C. tramways, where the cost was far in excess of the estimates of the committee. The Underground Co. was not asking the local authorities to lend their credit for all the millions required, but he thought they were entitled to their friendly co-operation in their great undertaking. But for the Underground Co. the enterprise would not now be in process of completion to supply a want which the London County Council and the local authorities should be the first to help to meet. Parliament had authorised each of their individual lines, and had provided for all the safeguards that could be devised in the interest of the travelling public, and the company had accepted those conditions. The enterprise had made possible the electrification of the District Railway, and the completion of a partially constructed tube railway, the Baker Street and Waterloo, on which work had been stopped for lack of capital. If the objects of the enterprise were attained, he did not think that the public cared by whom it was done. As facilities improved, the traffic would not only be actually, but relatively, greater. If the population of greater London should reach 7,000,000 in 1905, which

was very probable, the requirements for travelling would be 1,400,000,000, which seemed a modest estimate. It was the study of those broad and general facts that had led them to believe that the expenditure of those vast sums of money, to supply the growing needs of the population with the necessary transportation, was wanted. They would be able to carry on their tube lines 327,000,000 passengers, and on the District Railway 40,000,000 more passengers per annum than at present. The suggestion as to the position of the public with regard to the enforcement of the statutory obligations of the separate companies by the Underground Co. was entirely unfounded. The fact was that all the companies included in the undertaking were subject to the general laws applying to railways in this country. The facilities which were afforded a limited liability company for raising capital must be obvious to everyone, and recent experiences and developments in the money markets of the world had shown the wisdom of their policy. No profit was received by the old traction company, and the profits of the Underground Co. were entirely contingent and dependent on the success of the enterprise. In conclusion, he said that the company had undertaken to do what hitherto no one—not even the London County Council itself—had done or intended to, *i.e.*, to provide London with underground tube railways in accordance with the recommendations of the Joint Parliamentary Committee of 1901.

Mr. J. Clifton Robinson, the managing director and engineer of the London United Electric Tramways, was the last witness to give evidence before the Commission. He gave the Commission some information as to the character and operations of the London United Tramways. The company, he said, was formed in 1894 to acquire and reorganise the old West Metropolitan horse tramways. As the necessary powers were obtained, the company proceeded to convert the system to electric traction. Owing to the initial difficulties with Kew Observatory, the first section of their electrified system was only brought into operation at Easter, 1901, but rapid progress had been made in the three years which had since elapsed. Witness then spoke of the advantages of the system to the public. The lines in operation represented 36 route miles of tramway, 38 additional miles had been authorised, and 5 further miles passed by a House of Commons Committee in this session. There were 1½ miles of horse tramway still remaining. Mr. Robinson then went into details with regard to the passengers carried. In 1900 the passengers carried on the 9 miles of horse tramway then existing numbered some 8,000,000. When he ventured to predict that with the proposed extensions to Hounslow and Hanwell they would carry at the rate of 25,000,000 passengers a year, it was thought that he was over sanguine in his estimate, but, as a matter of fact, the number of passengers in 1902 was 36,000,000, while last year with the increased mileage over 45,000,000 were carried. That was equivalent to their carrying 126 times over, in the course of the year, the entire population of the districts served. The company were now running daily upwards of 30 workmen's cars, and, on an average, the passengers by those cars were carried over 5 miles for 1d., in several instances the distance being over 7 miles. The average fare over the whole system for an ordinary passenger worked out at less than ½d. a mile. In the equipment of their lines the company had, among other improvements, endeavoured to design a standard electric car which represented the application to street tramways of a type of saloon carriage approximating to those in use on our leading railways. Witness had had considerable experience of Parliamentary procedure in the promotion of tramways and the procedure of the Light Railway Commissioners. He was also familiar with the methods of procedure in the United States of America in granting concessions or franchises for the construction and operation of railways and tramways. Whereas in Great Britain tramway development had been seriously checked and hampered, in the United States—where a fair chance was offered to private enterprise—the electric tramway system had undergone a remarkable expansion. One could, for instance, with the exception of a few miles where the railway had to be utilised, make the entire journey from New York to Boston by various tramway lines. That represented a distance of 282 miles, and though he did not suggest that anyone ever would make such a journey, which would take 22 hours to accomplish, still the fact that it could be done showed what had been the development of tramways on the other side of the Atlantic. Suppose an individual did take that 22-hour trip, and wanted to go further, he could continue for another 76 miles to Newport, thus increasing the distance covered by him by electric tramway to close on 338 miles, at a total expenditure of $4½ in fares. Witness then went on to a consideration of the purchase clauses of the Act of 1870. So long as Clause 43 existed in its original form, a serious obstacle was placed in the way of electric tramway development. He considered that the term of years should bear some relation to the capital outlay. Looking dispassionately at the Act, it might be concluded that it had never had in its purview the working of tramways by any local authority at all. It seemed clear, from Section 19, that what the Act contemplated was that a local authority should lease any tramway it might either construct under a provisional order, or acquire by purchase under the terms of the Act. In the latter contingency, the provision was undoubtedly intended as a protection to tramway companies, and a compensation for the compulsory sale of their undertaking, under Clause 43 of the Act. It was inconceivable that it was ever contemplated that a local authority should be able to acquire, under such confiscatory conditions as those known as "scrap-iron" terms of purchase, and then themselves proceed to work the lines. Witness went at great length into the matter, contending that the granting of powers to any local authority to work its tramways entirely altered the intention of the Act. The first town in this country to work its own tramways was Huddersfield, where a company having abandoned its enterprise, the work was finished by the Corporation after they had unsuccessfully tried to induce other private companies to take over the work. When the Corporation applied to Parliament for authority to work the tramways, all they succeeded in getting was a Board of Trade licence, which expressly stated that the Corporation themselves might equip and work the lines only in the event of their failing to secure such terms, as, in the opinion of the Board of Trade, would yield the Corporation an adequate rent. It was further stipulated that if during the operation of the lines by the Corporation any company offered to lease and work the tramways, and to purchase the horses, cars, plant, &c., on terms to be approved by a valuer appointed by the Board of Trade, the Corporation should transfer the tramways to the company, and their own powers to work them should cease. Altogether it was the result of accident, and not design, and that precedent had been established. A great stumbling block in the way of tramway promotion was the Standing Order No. 22 (requiring the assent of two-thirds of the local authorities), which had been treated by the Standing Order Committees of both Houses as if it were an Act of Parliament, whereas it seemed that it could be dispensed with. The clause relating to the veto of frontagers had also been a fruitful source of contention. In the course of questioning by the Chairman, Witness said that it was hard to prove it now, but it was understood at the time that the Tramways Act of 1870 was not intended to apply to the Metropolis, and that the inclusion of London in its provisions was due to the casting vote of the chairman on a day when the Committee was thinly attended. With regard to the demands of local authorities, he was of opinion that they greatly handicapped tramways. From first to last he had had to negotiate with some 30 local authorities in the large territory which was now, or would soon be, covered by the London United Tramways. Had each district sought to own its little fragment of line, it would have been impossible for the system to have been laid down. Coming to a consideration of local rates and wayleaves, he said that he ventured to affirm that, if the cost of the construction of their tramways had not been swollen so greatly by the exactions of local authorities, they would have been well able on various parts of their system to carry passengers either at lower fares, or for longer stages for the same amount. On the question of a new tribunal, he said that he was strongly in favour of the creation of such a body, but he would suggest that it should not be formed hastily. Such a tribunal should concentrate within itself the best available talent. The number of members should be limited to five, and they should be appointed for a fixed term of years, and sit the year round, and not simply during the sessions of Parliament. They should have the widest possible range of powers consistent with that supreme authority of Parliament, which must be maintained. The special function of the tribunal should, in the first place, be to go fully into all necessary details respecting a proposed scheme, so that a vast amount of routine of the technical work now left to Committees might be anticipated by the tribunal. He was strongly of opinion that an inquiry before such a tribunal should take the place of the veto at present possessed under Standing Order 22, or that, if it should seem more desirable, Parliament might itself devise some means by which the enforcement of a standing order should rest with the Committee dealing with the Bill. He was against the London County Council or the Corporation having any exemption from the authority of the new tribunal. Continuing, witness dealt with procedure in Ireland. In reply to the chairman, witness said that he thought that the proposed tribunal should apply to the whole of Greater London. In conclusion, he spoke of the advantages of combinations of trams, tubes, and trains, and briefly outlined various routes which would be available in the future.

[The Commissioners are now considering their report, which it is hoped will be presented during this year.]

Leyton Tramways Bill.

The Bill promoted by the Leyton Urban District Council for the construction of tramways, &c., came before a Committee of the House of Commons, presided over by Mr. Heywood Johnstone on June 1st.

The case for the promoters was opened by Mr. Claude Baggallay, K.C. He said that the Bill was to authorise the Urban District Council to construct and work tramways, and to confer further powers on the Council in regard to their tramway undertaking. It further provided for the carrying out of certain street widenings, and the acquisition of land. The borrowing powers sought were as follows:—Tramways purposes, £128,000; street widenings, including the purchase of land, £14,300; and purchase of Lammas Lands for open spaces, £7,000. Counsel then described the tramways. It was intended to work the tramways electrically on the overhead system. There were provisions in the Bill that the Council should employ insulated returns, or uninsulated returns of low resistance, and that the Council should take all reasonable precautions in the construction and working of their undertaking so as not injuriously to affect by fusion or electrolytic action any gas or water pipes, &c. Certain provisions for the protection of Post Office telegraph lines were also contained in the Bill. Sanction was also sought to the running of omnibuses in connection with the tramways. With regard to the Council's electrical undertaking, they desired to have power to supply electrical energy to any adjacent local authority that desired to be supplied. The Bill also provided that the Council might purchase and sell or let for hire, but should not manufacture, electric motors, and apparatus for cooking, heating or ventilating. Counsel then described the various street widenings and improvements, and having dealt with the various petitions against the Bill (among them were the Great Eastern Railway, and several local authorities), proceeded to call witnesses.

Mr. Ralph Vincent, the clerk to the Leyton Urban District Council, was the first witness, and he gave evidence at some length on the various portions of the scheme.

Mr. J. Edward Waller, of Messrs. Kincaid, Waller & Co., the engineer to the scheme, was then called. He said that the greater portion of the West Ham tramways authorised in 1900 were now working and proving very successful. He considered the district of the proposed scheme was a very suitable one. Tramways Nos. 1 to 6 were all new tramways, and had a route length of 4 miles. One of the lines continued to West Ham, and ultimately to Aldgate. The eastward ramifications of the tramways would communicate with the docks. With regard to the northern portion of the scheme, there were two points at which the tramways ran just outside the borough into Walthamstow. The tramway would connect Walthamstow with London. With regard to the Lea Bridge, Leyton, and Walthamstow tramways, the Council were not yet in a position to acquire that line. They would seek power, however, to take over the tramways when the lease fell in. There were no engineering difficulties on the proposed routes. Questioned as to the capital expenditure, Mr. Waller explained that the capital proposed was £128,000, and that was for the power, construction, and equipment, including the cost of re-construction and equipment of the tramways which they purchased. He had considered the question of receipts, and had put them at a modest figure of 10d. per car-mile. The working expenses would, he estimated, be about 6d. per car-mile. The gross receipts would be £33,333, and from this had to be deducted the interest on sinking fund, which, at 5½ per cent., would be £6,160. He regarded tramway No. 1 as most important, but tramway No. 5 would be even more advantageous, as on such days as bank holidays, it would help to convey the people who were going to Epping Forest. Witness was examined at some considerable length on the various points raised by the petitioners against the Bill. In one or two cases objection was taken to a proposal to widen the roadway at the expense of the footpath, but Witness explained that the footpaths were some 20 ft. wide. As to the petition of the Lea Bridge Gas Co., who opposed on grounds of possible danger from electrolysis, Witness said that there were two other companies who were not opposing.

On Thursday, June 2nd, at the opening of proceedings, the Hon. J. D. Fitzgerald informed the Committee that the promoters had agreed to a clause with the Commissioners of Sewers. The clause was to the effect that the provisions of Sec. 31 of the Tramways Act, 1870, should in all respects apply to the river walling, banks, sewers, watercourses, &c., under the control of the Commissioners. Mr. Baggallay said that he agreed to that.

Mr. J. E. Waller was then re-called and examined by Mr. Hutchinson. He was not aware of any system of electric tramways of anything like that mileage which failed to work remuneratively. Witness was being examined on the possibility of the tramways being remunerative, when Mr. Paddon said that they were not pressing the Bermondsey clause against the tramways. Witness was then cross-examined at some length by Mr. Ram, K.C., on behalf of Lord Cowley's trustees, by Mr. Page on behalf of the Great Eastern Railway Co., and by Mr. Paddon on behalf of the Lea Bridge District Gas Co. In reply to Mr. Paddon, Witness said that portions of the Tramways Act of 1870 were incorporated in the present Bill.

Mr. Paddon: In your estimate for the construction of the new tramways, did you intend the clauses of the 1870 Tramways Act to apply to the horse tramways, which you propose to take over, as well as to the new lines?—I do not quite follow you. I have incorporated certain sections of the Act of 1870, and they will apply so far as the sections themselves show they apply.

Mr. Paddon: That is not my point. Sections 30 and 32 of the 1870 Act are incorporated in the present Bill, and the question which I am trying to raise is as to whether they apply to the reconstruction of the horse tramways which you take over and adapt to electric traction.—Witness read the commencement of Section 30: "For the purpose of making, forming, laying down, maintaining, repairing, or renewing any of their tramways, &c." He took it that that section would apply to work done by them in connection with those tramways in the way of making, forming, laying down, maintaining, &c. He took it that the reconstruction of the electric tramways was a reconstruction within the meaning of that clause.

Mr. Paddon: You say that these sections shall apply to such horse tramways as you transform into electric tramways?—Witness could not agree to a clause being inserted specifically stating that. The effect would be this: They had got a horse tramway, which was laid, so far as construction was concerned, in the same way as an electrical tramway, and when they reconstructed it, it would be practically the same as if it were to be continued as a horse tramway. He thought that, under Clause 30, if, in the process of reconstruction, they did any injury to the pipes, they would be responsible; but if a clause was put in to say that they were to treat the reconstruction of the tramways as though they were new tramways, they would be going back to the position of things before their tramways were constructed.

The Chairman: If the reconstruction is not covered by this, you will have no power to move the pipes at all?—Witness: We shall not want to.

Mr. Paddon: No; but I shall.

Witness: Yes; but the point I was trying to make clear is this: Supposing there happens to be, under the existing concrete, a pipe which they say is in danger, and should not be there. It has existed for years in this position. If I am to treat this as being a new tramway, they would call upon me to deal with it as though there was no tramway there now. I do not want to be deprived of the benefit of the purchase of the existing tramways at first cost by arbitration.

Mr. Paddon: You wish to treat this horse tramway as exempting you from giving the gas company any compensation that you would have to give them if you were laying down a new tramway?—Witness: Yes, certainly. They were not introducing any new element of danger because the tramways were being constructed for electric traction. If they had not come to Parliament to work electrically, they could have reconstructed without giving the Gas Co. any fresh protective clause.

Mr. Baggallay said that the attitude of the promoters was this: So far as they simply used the tramways as they now existed, they did not propose to give the Gas Co. the right of coming upon them and making them alter their mains and pipes, &c. If they altered them at all for the purpose of that Bill when passed, then he contended the company had all the rights they were entitled to under Sec. 30 already, and did not require any new rights.

Witness, replying to further questions by Mr. Paddon, said that he could not agree that the work of reconstruction should be considered as the laying down of a new tramway.

After further cross-examination, the Chairman asked to see the clause which was put in the Worthing and Hove Tramways Act of last year, and Mr. Paddon promised to get it. Counsel then briefly cross-examined Mr. Waller on the question of electrolysis. The tramways would be operated under the regulations of the Board of Trade made in 1893.

Mr. Paddon, replying to a member of the Committee, said that he did not intend to call witnesses to show that any injury had occurred to gas pipes where the Board of Trade regulations had been complied with. He would rely upon precedents, and he was going to ask the Committee that their common law rights should not be set aside by virtue of regulations made in 1893, which the Board of Trade had refused to modify, although Parliament had over and over again, by inserting clauses, shown the necessity for modification. Mr. Paddon then gave the gist of the General Electrolysis Clause, and cited cases where the clause had been inserted.

Mr. Baggallay said that the electrolytic action clause given in the Brighton case was given under special circumstances, and was put in under special circumstances in the other House. It had never been put in, in the House of Commons and sustained. It was refused in the Croydon Act. He then addressed the Committee on the question of the alterations of the regulations, and proceeded to re-examine Mr. Waller.

Mr. William Ivey, the chairman of the Tramways and Electric Lighting Committee of the Council, and Mr. R. W. Holmes, surveyor to the Council, having given evidence,

Mr. Paddon addressed the Committee on the question of electrolysis. The object of the Gas Co. in seeking the clause was the protection of their common law rights. The Council could come and construct tramways, and by virtue of incorporating regulations which, he contended, were nugatory, could avoid responsibilities. Passing to a consideration of the Board of Trade regulations, he said that in 1893 the Joint Committee considered the question. There were six tramways in existence at the time when the regulations were made, and no alterations had been made in those regulations since, except where special companies had been exempted, although the number of tramways had largely increased.

The Chairman, at the conclusion of counsel's speech, said that the Committee were of opinion that if any doubt should exist with regard to the applications of Sections 30 and 32 of the 1870 Act, it was covered by clause 21. With regard to the insertion of gas companies' names in clause 67A, that was agreed to, and with regard to the other question raised by the company, *i.e.*, the insertion of a clause similar to clause 10 of the Brighton Corporation Act of 1903, the Committee had indicated before that they should only insert that upon substantial evidence being given before them with regard to the need of a clause of that character. Apparently the Board of Trade had made their regulations a good many years ago, and had been called upon to alter them, but, like that Committee, they were waiting for evidence.

On Monday the question of the insertion of the Bermondsey clause with regard to the Council's electric light undertaking was considered at some length. The Council, in their Bill, take power to supply electrical energy to adjacent local authorities, and it was in connection with this that the gas company desired the Bermondsey clause to be inserted. Evidence was given by Mr. C. G. Musgrave, the Chairman of the Electric Lighting Committee of the Council, who described the works belonging to the Council.

Tyneside Tramways and Tramroads Bill.

This Bill, which has already been passed by a Committee of the House of Lords, came before a Committee of the House of Commons on Tuesday.

Mr. Balfour Browne, K.C., who appeared for the promoters with the Hon. J. D. Fitzgerald, Mr. Short, and Mr. Macassay, said that the object of the Bill was to secure through communication over the Newcastle Corporation lines, and *vice versâ*, at the various points where the two systems met. The only petition against the Bill was from the Newcastle Corporation, but the company were not hostile to the Corporation, as they were not asking for anything that they were not giving in return. Counsel then described the negotiations which had taken place in regard to the matter, and stated that there were a large number of waterside manufacturers who were in favour of the scheme.

Mr. William McLellan, engineer and manager to the company, was the first witness called. He said that manufacturers employing 26,700 men had petitioned in favour of the Bill. There would be no difficulty in running the cars as proposed.

Cross-examined by Mr. Honoratus Lloyd, K.C (for the New

castle Corporation), Witness would not admit that the cars run by the company were very often late. At the present time they ran an eight-minute service, and this would, in all probability, be continued if they got the running powers.

Mr. Lloyd then cross-examined witness on the precedents for compulsory running powers, and Witness admitted that, with the exception of Salford and Manchester, there were no such compulsory powers. Where powers were given, they were worked by agreement.—The Committee adjourned.

On Wednesday, a number of local witnesses having been called, Mr. Stephon Sellon, consulting engineer to the British Electric Traction Co., gave technical evidence in support of the scheme. There were no difficulties in the way of running the through trams.

Mr. William Murphy, Chairman of the Dublin United Tramways Co., Mr. Joseph Glen, secretary to the Belfast Street Tramways, and other witnesses spoke of the advantages of through communication over the two systems.

The case for the opposition was then opened by the calling of Mr. Le Rossignol, the tramways manager to the Corporation, who stated in the course of his evidence, that the Corporation had 23 route miles of double track, whereas the company had only 3½ miles double, and 5¼ miles single track. He could see great difficulties in the way of the proposed running powers working smoothly. If a car broke down outside the central station, they would, if it was one of their own cars, take it to their depôt half-a-mile away, whereas if the car was one belonging to the company, it would have to be carried 4 miles to Wallsend, where the company's sheds were.

Petitions.—Amongst the petitions, deposited in the Private Bill Office of the House of Commons, in opposition to private Bills, are the following:—The Newcastle-on-Tyne Electric Supply Co., against the Newcastle-on-Tyne Corporation Bill; Flint County Council and others, against the North Wales Electric Power Bill; the Midland Railway and the Lancashire and Yorkshire Railway, against the West Riding Tramways Bill.

Electric Lighting Provisional Orders (No. 7) Bill.—On June 2nd the Examiner found that Standing Orders had been complied with in the case of the above Bill, which confirms provisional orders granted by the Board of Trade in respect of the following districts:—Order granted to the Clyde Valley Electrical Power Co., in respect of the Burgh of Barrhead in the County of Renfrew; order granted to the Clyde Valley Electrical Power Co., in regard to a portion of the Parish of Bothwell in the County of Lanark; order granted to the Clyde Valley Electrical Power Co., in respect of portions of the Parishes of Eastwood and Cathcart in the County of Renfrew; order granted to the Clyde Valley Electrical Power Co., in respect of the Burgh of Johnstone and a portion of the Parish of Paisley; order granted to the Clyde Valley Electrical Power Co., in respect of the Burgh of Milngavie and of portions of the parishes of Old and New Kilpatrick in the County of Dumbarton; order granted to the Clyde Valley Electrical Power Co., in respect of the Burgh of Lanark; order granted to the Clyde Valley Electric Power Co., in respect of portions of the Parish of Renfrew; order to be known as the Shettleston Electric Lighting Order, granted to the Clyde Valley Electric Power Co., in respect of portions of the Parishes of Glasgow and Old Monkland. Notice of opposition to every case except that of the Lanark order.

Electric Lighting Provisional Orders (No. 8) Bill.—The above Bill came before the Examiner on June 2nd, and Standing Orders were found to have been complied with. The Bill confirms orders granted by the Board of Trade to the following areas:—Order granted to the Urban District Council of Caerphilly in the County of Glamorgan (power is given to enter into agreements with the South Wales Electrical Power Distribution Co.); order granted to the County of Surrey Electrical Power Distribution Co., Ltd., in respect of the Parish of Cheam in the Rural District of Epsom in the County of Surrey; order granted to the Mansfield Woodhouse U.D.C. in the County of Nottingham; order granted to the Shropshire and Worcestershire Electric Power Co., in respect of the Urban District of Bromsgrove in the County of Worcester; order granted to the Gloucestershire Electric Power Co., in respect of the Rural District of Stroud and the Parish of Dursley; order granted to the U.D.C. of Sutton-in-Ashfield in the County of Nottingham. The Barry Railway Co., and the Rhymney and Aber Valleys Gas and Water Co., are opposing the Caerphilly Order.

Holywood Tramways Bill.—All opposition to this Bill has been withdrawn, and it has accordingly been referred to the Committee on Unopposed Bills.

The Revived Thames Steamboat Service.—The first Thursday in June saw the revival of a steamboat service on the Thames, after a lapse of some three years. The new service is claimed to provide a 35 minutes' journey to Greenwich, from Westminster, and a correspondingly shorter one from the intermediate port of call, London Bridge. The 20 minutes' service and low fares should prove an attraction to those whose interest lies down the river. The run is claimed to be faster than tram, rail or 'bus; taking into account the very doubtful railway facilities, the claim is probably justified, and if the river steamers were as accessible, and their stopping places as well known, to the man in the street as in the case of the other modes of travel, the venture would, no doubt, gain its fair share of traffic.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Atavism.

I ought to thank "F. B." for a pleasant two columns of amusement, though I may regret that in place of accepting my much-abused article on gas in the spirit in which it was written, he should sling at me paraphrases of scripture. But, perhaps, the atmosphere of regeneration in which I dwell leads him to do so.

With the encouragement of my critic's lead, I, also, should like to do something religious, like the shipwrecked sailors in the boat, who had a collection in the absence of a capacity for other means of grace. I more particularly tell my story, in that it points a moral rather than adorns my tale, and, moreover, it is of atavistic memory, and will thus be pleasant to my critic.

An elderly and long-gone relative, whose load factor of holiness, while it had very high peaks, had a very moderate average indeed, was, during a peak of load, very urgent at prayer meetings. At one of these functions, when the booster was hard at work and pressure high, his coat tails reached ignition temperature, to the horror and consternation of an aged lady, who tugged at his sleeve and communicated to him the progress of his coat's damnation. The thanks she received were, "If you had been attending to your prayers, my good woman, you would not have noticed that." Now the coat tails of "F. B." and all of us interested in electrical matters are very much on fire, but "F. B." prefers to let them burn and to sing his hymn of praise and prayer rather than be told of that taking place which promises to extend to regions within the coat tails. Are we so perfect in all our practice that it is useless to point out that no longer can we obtain through the gas engine and the dynamo, more light than by direct gas burning? Is it not perfectly true that the system of domestic electric lighting is much too expensive for general adoption?

Has not the introduction of the mantle enormously decreased the consumption of gas per unit of light? Further, is there any serious obstacle to the arrangement of gas, so that the fumes will no longer remain as a danger to health, but will escape to the chimney? Need there even be any difficulty in so arranging a gas connection as to be able to switch it on from the door of a room. If not desirable to loop a gas pipe so far round, can we not do it electrically? I am sure "F. B." would easily design a switch to do this. It appears to me about the most foolish thing in the world to play the part of the ostrich. Yet that is the attitude of all those who will have no criticism of things electrical. With them everything is for the best in the best possible of worlds. Are 12 lbs. of coal consumed per unit? Yes, but it would be the most atrocious atavism to go back to the 1¾ lbs. per I.H.P. (or, say, 3 lbs. per KW. equivalent) to which we had got down in the eighties. "F. B." talks sarcastically of retrogression from electric railways to rickshaws, walking, standing, but there is a fourth term in the atavistic series, going backwards to wit, and it is this species of atavism against which I have raised my voice.

Contrary to "F. B.," I think there is a good deal of hope for electric lighting, nor can I think he has found all he professes to have found in the article of which he complains, or that I said there was no hope, for there is a margin for economy too terrific to think on calmly. And there are margins for simplicity, for lamps which will run clean 100 hours, not to speak of 1,000, for stations that will send out current of even fairly steady voltage, not to mention avoidance of rapid flicker; for such storage as will give us bright filaments, and not dull red ones every time a passing cloud looms up. Difficulties!!! Of course there are difficulties, and it is because these are so patent to me that I do lift up my voice and howl. The Bunsen burner is old enough, but the gasmen never used it as a light producer until they were compelled to do so. Now they use it and they mix air with the gas to improve the light. Very probably their great regret is that they cannot mix it in before it passes the "Mechanical Ananias" in the cellar.

E

If it would stir electrical inventors and lighting station engineers to do something to stop the standing still, I would invite them and "F. B." to find out something of the newer developments of gas lighting, and seriously to ask themselves if they ought to rely on that ancient shibboleth of the contaminated atmosphere. The less said about contaminated atmosphere the better for "F. B.'s" lauded tube. Any man of sense knew that the tubes would fail to a degree, but the warning was disregarded. There was only one foulness—that of the locomotive smoke, and no ventilation was provided for, and at least to-day the rickshaw and Coolie from the Bank to Shepherd's Bush would get anybody's preference even if a trifle of 10 minutes longer per journey. "F. B." is unfortunate in his illustrations, and in none worse than his Scriptural paraphrases, for on May 27th the sun *was* darkened at noon day and our light *did* utterly fail; but perhaps he uses gas, and was saved the idle half hour I was compelled to spend while the lights were dim. I quite fully appreciate his references to progress *versus* cheapness, but "F. B." will be the first to acknowledge that cheapness is the only factor considered by many engineers who ought to know better. But in supplying light to the million what they want is light, and you cannot teach the million anything about health and ventilation or the benefit they should receive by paying more. Even a steam engine is bought on the lowest tender, though its true cost may be much higher than the highest tendered. Perhaps I have been unfortunate in my localities at the time, but I have yet to see an incandescent lamp burning brightly during a "daylight" thunderstorm. "F. B." scoffs when told that his coat tails are on fire. So did we all of us at the enemy of four years ago, and it is not many weeks since Russia sat in the seat of the scornful. Progress in electrical matters will never be gained by ignoring the methods of the enemy, nor by blinking our own shortcomings. I should also like to say that the Welsbach gas light by no means represents the best or cheapest system of gas lighting. Double and treble the light per cb. ft. may be had by other systems, and "F. B." does not even appear to know of them ! ! ! With such an attitude of placid content can progress be expected ?

W. H. Booth.

Referring to the article headed "Atavism" in this week's issue, I fancy the writer would have found a very fine instance in the Glasgow Subway Co. Here is an underground railway with two circular cables, each 7 miles long, with all the disadvantages of enormous friction and cost of upkeep, and yet it is run at less than *half* the cost of any similar electrical undertaking. In case any of your correspondents who may be qualified to deal with such matters care to go into the question, I can easily procure the figures. It seems to me that it is not so much a question of "Atavism," but of the "survival of the fittest."

Dambo.

Small Electrical Supply Works.

Latterly, a tendency has arisen to speak well of everything connected with electricity supply if of immense dimensions; in fact, unless one can give their experience of dealing with 5,000-KW. sets "or something of that order," they will receive a scanty hearing. But is not "the proof of the pie in the eating ?" then, somehow, these "immense things" are never quite "done." The contractors appear never to have "quite finished"; at times, perchance, they appear to have "cleared out," then presently one meets them working merrily away at a distant end of the "immense" job.

"The powers that be" get hold of the notion—or to be more correct, the notion gets hold of them—that they must keep on extending, and all will come right in the end. But matters appear to be as far removed from this so-called end as ever they were, and to all intents and purposes ever will *be*.

The "motor load" is always put forward as the one thing that will put "everything right," but when one comes to deal with actual facts, the factories and workshops are found not in the highways, but down in the byways, where it would never pay to lay an expensive concentric main.

Again, reference is usually made to small electrical supply works, as concerns that no longer justify their existence. On examining it closely, there is just as much—and not much more—in this argument, as in the supposition that because an "immense" hotel was being built in a district everyone should go and live there, and break up the happy little home.

There are at least 12 small supply works in the United Kingdom with a capital expenditure of less than £10,000, and with an average capital expenditure per KW. capacity of £52. It would be of very timely interest if the engineers of such small stations would furnish particulars of their costs and records, as they alone can prove that a prosperous future lies before small stations, which are in many ways of more importance to the electrical industry at large than those "immense" schemes.

Same Job.

Municipal Appointments.

Will you allow me a portion of your valuable space to heartily endorse "Desperandum's" letter. The troubles he states also apply to a metropolitan borough with which I have the ill fortune to be connected; further, the policy of sweating at the wrong end of the stick is in vogue. Can an officer in charge of a shift possibly be expected to successfully exercise his authority when his subordinates are not only upheld in their impertinences by a biassed committee, but receive greater pay than he, this inconsistency being well known to these employés ?

Thanks to an over-prying committee—whose pals, the workmen of the station, are its informers—an air of distrust prevails between men and officers. A word dropped here or an action there by an officer in the presence of his men, is misinterpreted and adopted as the topic of conversation at the next meeting of the said men with their friends on the committee in the public bar of the —— Tavern. This officer at a future date finds his application, say, for an increase of salary, refused on some trivial excuse, owing to the ill favour of certain of the committee, this refusal being meekly acknowledged by a baby chief.

Yet another point. The committee, though severely non-technical, attempts to assert its authority by criticising small details—as, say, a sudden variation in pressure—which the engineer knows to be entirely unavoidable. Even the most obvious explanation is considered an attempt to "fool" the committee, and those responsible are subjected to increased petty worries.

Let those who anticipate accepting a municipal appointment bear *Punch's* advice in mind—

"Don't."

The Telephone Line between Lisbon and Oporto.

On my return to Portugal, after an absence of some weeks, I read in the number for last May of the *Journal Télégraphique*, of Berne, an announcement taken from your journal, according to which the telephone line recently erected between Lisbon and Oporto has been constructed for the Portuguese Government by the Anglo-Portuguese Telephone Co., who are working the public telephone systems of these two towns. I now ask you, Sir, to kindly rectify this announcement. The line in question is, indeed, destined to join the telephone lines worked by the said company, but it has been constructed, and will be maintained and worked, exclusively at the expense of the State, by the engineers and agents of my department, that is to say, without any intervention from this company.

Thanking you in anticipation, &c.

Paulo Benjamin Cabral,
L'Ingénieur Inspecteur Général des Télégraphes et des Industries Electriques.

Lisbon, *June 4th*, 1904.

[INFORMATION WANTED.—A correspondent wants to know the name of the makers of "Adelphi" varnish, for armatures and field coils of dynamos.—EDS. E.R.]

THE REPULSION MOTOR.

By F. W. CARTER, M.A. Cantab.

(*Continued from page* 900.)

Flux in Stator, and Counter E.M.F. in Stator Coils.—Assume that of the total flux due to the stator current a fraction $1 - x$ leaks between stator and armature, that is, for every unit threading the stator coils, a fraction x threads

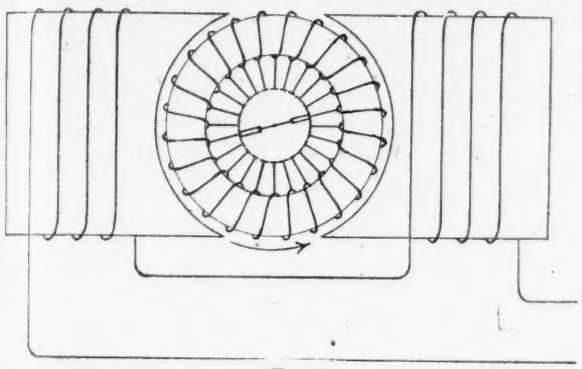


Fig. 1.

the armature coils. Similarly, assume that a fraction $1 - x^1$ of the flux due to the armature current leaks between armature and stator. Then the total field at θ in the stator is—

$$\frac{B}{x}\cos\theta\sin pt - B^1 x^1 \cos\overline{\theta - a}\sin\overline{pt + B}.$$

The total flux through the coil lying between θ and $\theta - \frac{\pi}{2}$ is—

$$\int_{\theta-\frac{\pi}{2}}^{\theta}\left\{\frac{B}{x}\cos\theta\sin pt - B^1 x^1\cos\overline{\theta - a}\sin\overline{pt+\beta}\right\}d\theta$$

$$= \frac{B}{x}(\sin\theta + \cos\theta)\sin pt - B^1 x^1(\sin\overline{\theta - a} + \cos\overline{\theta - a})\sin\overline{pt+\beta}.$$

The counter E.M.F. generated in this coil is—

$$e = \frac{B\,p}{x}(\sin\theta + \cos\theta)\cos pt - B^1 x^1 p(\sin\overline{\theta - a} + \cos\overline{\theta - a})\cos\overline{pt+\beta}.$$

Assuming the winding uniformly distributed over the pole face, the total counter E.M.F. in the m turns forming the winding of one pole is—

$$E\sin\overline{pt+\varepsilon} = m\frac{2}{\pi}\int_0^{\frac{\pi}{2}} e\,d\theta$$

$$= \frac{4\,m\,p}{\pi}\left[\frac{B}{x}\cos pt - B^1 x^1\cos a\cos\overline{pt+\beta}\right]$$

Taking account of equations (2) and (3), we get $E\sin\overline{pt+\varepsilon}$

$$= \frac{4\,m\,p\,B}{\pi\,x}\left[\left\{1 - L\,x\,x^1\cos a\frac{L\,p^2\cos a - R\,\omega\sin a}{L^2p^2 + R^2}\right\}\cos pt + L\,x\,x^1\cos a\frac{R\,p\cos a + L\,\omega\,p\sin a}{L^2p^2 + R^2}\sin pt\right] \quad (6)$$

$$= \frac{4\,m\,p\,B}{\pi\,x}\frac{\left[(1 - x\,x^1\cos^2 a)^2 + \left(q + \frac{\omega}{p}x\,x^1\sin a\cos a\right)^2\right]^{\frac{1}{2}}}{[1+q^2]^{\frac{1}{2}}}\sin\overline{pt+\varepsilon} \quad (7)$$

where $\tan\varepsilon$

$$= \frac{R}{L\,p} + \frac{(L^2p^2 + R^2)(1 - x\,x^1\cos^2 a)}{L\,p\,x\,x^1\cos a(R\cos a + L\,\omega\sin a)}. \quad (8)$$

$$= q + \frac{(1+q^2)(1 - x\,x^1\cos^2 a)}{x\,x^1\cos a\left(q\cos a + \frac{\omega}{p}\sin a\right)}. \quad (9)$$

Torque.—The counter E.M.F. is very nearly equal and opposite to the applied E.M.F., the difference between them being the CR drop in the stator coils. Assuming the counter E.M.F. to be constant, therefore, we obtain from equation (7)—

$$B = \frac{\pi\,x\,E}{4\,m\,p}\times\frac{[1+q^2]^{\frac{1}{2}}}{[(1 - x\,x^1\cos^2 a)^2 + (q + \frac{\omega}{p}x\,x^1\sin a\cos a)^2]^{\frac{1}{2}}} \quad (10)$$

Hence from equation (5)—

$$T = \frac{n^2x^2E^2}{2\,m^2p^2\,L\,p}\times\frac{(p\cos a - q\,\omega\sin a)\sin a}{(1 - x\,x^1\cos^2 a)^2 + (q + \frac{\omega}{p}x\,x^1\sin a\cos a)^2} \quad (11)$$

Maximum Starting Torque.—At starting, when $\omega = 0$, equation (11) becomes—

$$T_0 = \frac{n^2x^2E^2}{2\,m^2p^2\,L}\cdot\frac{\sin a\cos a}{(1 - x\,x^1\cos^2 a)^2 + q^2}.$$

This is a maximum when—

$$\frac{(1 - x\,x^1\cos^2 a)^2 + q^2}{\sin a\cos a}$$

is a minimum.

This occurs when—

$$(1+q^2)\sec^6 a - 2(1 + q^2 - x\,x^1)\sec^4 a - 3(x\,x^1)^2\sec^2 a + 2(x\,x^1)^2 = 0. \quad (12)$$

If q were zero, and we shall find that it should be made as small as practicable, the solution of equation (12) would be—

$$\tan^2 a = \sqrt{1 - x\,x^1 + \tfrac{9}{4}(x\,x^1)^2} - \tfrac{3}{2}x\,x^1. \quad (13)$$

This will not be very different from the true solution of equation (12).

Power Factor.—The counter E.M.F. is seen from equation (7), to be in phase $\overline{pt+\varepsilon}$, where ε is given by equation (9). The current is in the phase of the applied field (*i.e.*, pt), thus lagging behind the counter E.M.F. by the

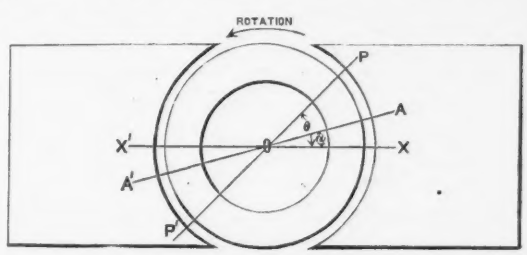


Fig. 2.

angle ε. The applied E.M.F. will be rather nearer to the phase of the current than the counter E.M.F., since it contains an additional component (the C R drop) in phase with the current. The power factor will therefore be nearly $\cos\varepsilon$, where ε is given by equation (9).

(*To be continued.*)

THE CONTINENTAL ELECTRICAL ENGINEERING INDUSTRY.

The Glow Lamp Syndicate and New Competitive Factories.

It is generally impossible to trace rumours to their source of origin. This has been the case in relation to the international glow lamp syndicate which was formed by German, Austrian and Dutch firms a year or so ago with headquarters in Berlin. It was recently reported that the dissolution of the combination was contemplated on the alleged ground that new incandescent lamp factories were being built in Germany and Upper Italy, if not also in Austria. Whether the factories are being established is quite immaterial at the present moment, but even if the rumour in this sense is correct, it did not consititute a valid reason, at all events, from the syndi-

cated makers' point of view, for the extinction of the organisation. This view of the question has apparently prevailed with the majority, who have now rejected a proposal made by one of the members in favour of the dissolution of the syndicate; and the latter will therefore continue its activity.

The Allgemeine Electricity Co., of Berlin, is reported to have established an independent company for the manufacture of Nernst lamps in England, this referring, apparently, to the recent registration at Somerset House. The new company will not conflict with the Nernst Electric Light Co., as the latter's sphere of manufacturing applies to business in other countries. The A.E.G. has now practically absorbed the Union Electricity Co., and the shareholders in the Union Co. have adopted resolutions deciding upon the dissolution of the company and the appointment of liquidators for this purpose.

German Undertakings.

The Accumulator Works Co., of Berlin—Hagen, which has a share capital that has remained stationary at £312,500 for at least six years, has just declared a dividend at the rate of 12½ per cent. for 1903, this rate comparing with 10 per cent. in each of the five preceding years. Among the various enterprises in which this Tudor battery company is interested, may be mentioned the Russian Tudor Accumulator Co., the Oerlikon Accumulator Co., the Spanish Tudor Accumulator Co., of Madrid, the Tudor Accumulator Co., of London, and several electricity works and tramways. The company's accounts show net profits amounting to £53,013, as against £47,777 in 1902. The former sum has been arrived at after meeting working and general expenses and writing off £22,204 for depreciation, as compared with £15,225 in 1902. In this connection it should be stated that the expenditure on the works' machinery, plant and patterns has been written off entirely. The report of the directors observes that the various undertakings in which the company is financially interested lead to the hope of further favourable development, and that almost the entire share capital of the Pollak Accumulator Co. has been acquired. At the recent meeting, the directors were authorised to raise additional capital to the extent of £100,000 for the purpose of enabling them, without having to convene a special assembly of shareholders, to purchase or participate in any undertaking likely to be of value to the company.

The report of the Mix & Genest Telephone and Telegraph Works Co. states that, as in the latter part of 1902, the sales during 1903 were brisk, and the turnover in connection with private customers was greater than at any previous period. At the same time a larger demand was experienced from the State authorities, although it was less than in the case of certain former years, which were specially favourable. The prices realised, however, did not recover from the decline of recent years, and it is to this fact that the financial results have not advanced in the same proportion as the volume of business. After writing off £9,259 for depreciation, as compared with £9,372 in 1902, the accounts for 1903 show net profits amounting to £18,343, as against £9,897 in the preceding year. A dividend at the rate of 7 per cent. is proposed on the share capital of £180,000, this comparing with 4 per cent. in 1902, The report remarks that the independent branches at Hamburg and Cologne are developing, and have further increased their sales and profits, while in the case of the London branch, whose activity was detrimentally affected in former years owing to the unfavourable business situation in England, a material improvement has also taken place. If the more satisfactory position of trade continues, the directors express the hope that in view of the increased opportunity for finding remunerative employment, the present severe competition will be mitigated, and prices return to normal conditions.

The general meeting of the Company for Electrical Enterprises of Berlin, which is purely an investment undertaking for electrical works of various kinds, adopted the report and accounts for 1903, and a resolution declaring a dividend at the rate of 3 per cent. as compared with *nil* in the previous year, and the transfer of £7,500 to a special reserve fund. In reply to a suggestion that the latter sum should be devoted to the payment of an additional ½ per cent., Director Kocherthaler stated that the crisis through which the electrical industry had just passed, still rendered it necessary to exercise caution, and the reserve in question was for the purpose of strengthening the company in the eventuality of a return of unfavourable times. The share capital amounts to £1,500,000, while the bonded debt totals £1,750,000. The 3 per cent. dividend has been paid out of the net profits, which reached £61,050 as compared with only £687 in 1902. In 1901 the distribution was at the rate of 4 per cent., in 1900 8 per cent., and 10 per cent. in each of the two preceding years. The directors' report states that a considerable portion of the company's holding of preference shares in the Anglo-Argentine Tramways Co. has been disposed of at a profit as compared with the book value, while the advances made to the same tramways company and to the Chilian Electric Tramways and Lighting Co. have been converted into shares or bonds of the companies in question.

French and Other Companies.

The report of the French Thomson-Houston Co., which has declared a dividend at the rate of 5 per cent. on a share capital of £1,600,000, points out that the tramways in which the company is interested, yielded increased receipts during 1903 without the expenses advancing in the same ratio, and only one of the nine companies failed to make a distribution of profits. It has been decided to add to the company's business the construction of steam turbines on the Curtis system as promoted by the General Electric Co. in the United States, and for this purpose the scope of the Postel-Vinay works has been extended, the title changed to that of the Ateliers Thomson-Houston (Anciens Etablissements Postel-Vinay), and the capital of this particular company increased from £120,000 to £280,000. The patent rights for this type of turbine have been acquired by the Thomson-Houston Co. for France and French Colonies and for Italy, Spain, Portugal, Greece, and Egypt. The directors' report refers to the acquisition by the Union Electricity Co., of Berlin, of the patent rights for the Curtis turbine in the north and east of Europe, and states that the fusion of the former with the Allgemeine Co. has led to an understanding between the French Thomson-Houston Co. and the Allgemeine Co. for the limitation of markets and mutual co-operation. It is provided, under the arrangement, that the German company renounces all rights in the Riedler-Stumpf steam turbine for France, and undertakes only to sell electrical machinery in that country through the agency of the Thomson-Houston Co. On its part, the latter guarantees sales amounting to a minimum of those hitherto effected by the Allgemeine Co. in France, although they are not to exceed 7 per cent. of those transacted by the French company. In addition to this, the A.E.G. and the Mediterranean Thomson-Houston Co. have jointly formed a new Italian company, a definite portion of whose orders for the supply of turbines and electrical machinery will be placed with the French company.

The prosperity of the Aluminium Industry Co., of Neuhausen, which has been evidenced by the accounts issued for a number of years, exhibits not the slightest sign of abatement, and, in fact, the company continues to show progressive results on the stationary share capital of £320,000 and the diminishing bond issue, which has now been reduced to £293,500. After deducting working expenses and interest on the bonds, the accounts for 1903 indicate profits amounting to £102,644, as compared with £93,335 in 1902. The sum written off for depreciation, and the allocations for reserve fund, directors' fees, and benevolent fund leave £51,200 available for distribution among the shareholders, at the rate of 16 per cent., as against 15 per cent. in 1902, and 13 per cent. in 1901. The directors state that all the company's works were sufficiently employed during the year, and the consumption of aluminium and carbide of calcium had largely increased, although not to the extent of entirely occupying the works at Neuhausen, Rheinfelden, and Lend Rauris, which represent a total of 24,000 H.P. The company has, therefore, turned its attention to other manufacturing branches, of which the report does not give any information, although it states that they have contributed towards the profits. It is proposed to erect new works at Rheinau-Balm for the utilisation of water-power, and as the negotiations for the taking over of the Héroult patents for the production of steel have been brought to a definite conclusion, an installation for this purpose will presumably be carried out in the course of the summer.

The gross profits of the Baden Motor Co. for Applied Electricity, which is closely associated with the Brown-Boveri Co., amounted to £27,865 in 1903, as compared with £26,343 in the preceding year. After meeting expenditure and interest on the bonds, there remains a net profit of £13,308, which, together with the balance brought forward, makes a total of £20,883 available for disposal, as against £8,030 in 1902, but in the latter year a large sum was written off for depreciation. It is proposed to pay a dividend at the rate of 4 per cent. on the share capital of £400,000, whereas a year ago no distribution took place, as most of the surplus was carried forward. The report of the directors of the company, which is interested in various lighting and power enterprises, supplies machinery and undertakes a wiring business, states that the various undertakings made further progress, and the prospects for the current year are favourable.

The Société Générale Belge d'Enterprises Electriques of Brussels, which has a share capital of £240,000, is understood to be intimately related to the Berlin Union Electricity Co., which is being entirely absorbed by the Allgemeine Co. of Berlin. Interested in a number of Belgian and foreign electric lighting and tramway undertakings, the Société Générale has realised from the yield on investments, commissions, &c., net profits totalling £10,448, which allow of the payment of a dividend at the rate of 4 per cent. for 1903, as compared with no distribution in the preceding year. The company is in competition with the Belgian Empain syndicate for the erection of a large new generating station for the municipality of Brussels.

The shareholders of the Union Electricity Co., of Vienna, which has terminated the year 1903 with a deficit of £140,000, have just adopted a scheme for the reorganisation of the undertaking with a view to its being placed upon an improved financial basis. The scheme provides—and this partly as a result of the amalgamation of the German Allgemeine Co. and the Berlin Union Co.—for the conversion of the Austrian concern into the A.E.G.-Union Co., the reduction of the share capital to £60,000 and the creation of new shares to the extent of £100,000, so as to bring the total capital up to £160,000. It is also intended to make changes in the internal organisation of the company, and on their completion new branches of manufacture are to be embarked upon, especially in regard to steam turbines of the type promoted by the Allgemeine Co., of Berlin.

LEGAL.

The Hessle Gas Light and Coke Co., Ltd.

In the Chancery Division of the High Court of Justice on Tuesday (June 7th), Mr. Justice Farwell in this case had before him a petition asking the Court to sanction alterations in the memorandum of association. The company was formed under the Companies' Acts of 1856 and 1857, but it had never been registered under the

Act of 1862. It was formed to manufacture and sell gas and coke, but it now wished to have power to carry on the business of an electric light and power company, to deal with the residual products of gas, to supply electric fittings to consumers, and to borrow capital. The company was a most prosperous one, the shares which were issued at £15 standing now at a premium of £26. The shareholders were absolutely unanimous in favour of these powers being acquired.

Mr. Justice FARWELL sanctioned the alterations.

Mr. Jenkins, K.C., appeared for the petitioners, and Mr. Cann for the local authority to oppose, but his Lordship declined to hear him on the ground that they had no *locus standi*.

BUSINESS NOTES.

Electrical Wares Exported.

WEEK ENDING JUNE 9TH, 1903.

Adelaide	Value £51
Aden	92
Alexandria. Elec. fuses	140
Amsterdam	17
Auckland	325
„ Teleph. mat.	2,040
Bangkok	126
Bluff	108
Bombay	—
„ Teleg. mat.	41
Buenos Ayres. Teleph. cable	285
Calcutta	284
„ Teleg. mat.	1,005
Cape Town	20
Colombo	226
Copenhagen	43
Delagoa Bay	67
Durban	383
East London	12
Fremantle	147
Hamburg. Teleg. mat.	130
Kobe	219
Lisbon	45
„ Elec. cable	350
Malta	18
Mauritius. Teleg. mat.	546
Melbourne	101
New York	12
Perth	1,051
Port Elizabeth	460
Quebec	70
Rangoon	9
Rio Janeiro	26
„ Teleg. cable	715
Santos	80
Shanghai	82
Singapore	1,464
Stockholm. Teleg. wire	44
Sydney	174
Tientsin. Teleg. mat.	313
Wellington. Teleg. mat.	35
Yokohama	328
Total	£11,684

WEEK ENDING JUNE 7TH, 1904.

Adelaide	Value £115
Aden	17
Alexandria	111
„ Elec. t'mway goods	284
„ Teleg. mat.	197
Amsterdam	90
Auckland	42
„ Teleg. mat.	458
Bahia. Teleg. mat.	10,500
Bangkok	260
Bombay	402
Boulogne	20
Brisbane. Teleph. cable	317
Buenos Ayres	186
„ Teleph. cable	410
Calcutta	504
„ Elec. machinery	315
„ Teleg. mat.	325
„ Teleph. mat.	361
Cape Town	41
„ Elec. machinery	1,446
Christchurch	17
Colombo	165
Copenhagen	74
Durban	251
„ Elec. machinery	752
„ Teleg. mat.	1,086
East London	843
„ Elec. machinery	335
„ Teleg. mat.	218
Fiume	80
Flushing	31
Fremantle	209
„ Elec. machinery	464
„ Teleg. mat.	546
Gibraltar	410
Hamburg	199
„ Teleg. mat.	200
Hong Kong	103
Kobe	887
Launceston	270
Lisbon. Teleph. mat.	90
Madras	124
Mauritius. Teleg. mat.	28
Melbourne	15
Monte Video	25
Oamaru	108
Paris	46
Perth	629
Port Elizabeth	82
Rio Janeiro	179
„ Teleg. mat.	1,728
Rotterdam	47
„ Elec. fuses	43
St. Petersburg	99
„ Teleg. mat.	100
Shanghai	736
Singapore	77
„ Elec. machinery	275
Stockholm. Teleg. mat.	110
Sydney	259
„ Elec. machinery	907
Wellington	411
„ Teleg. mat.	1,013
Yokohama	1,259
Zanzibar. Teleg. apprts.	170
Total	£31,581

Foreign Goods Transhipped.

Sydney. Elec. lamps	Value £50

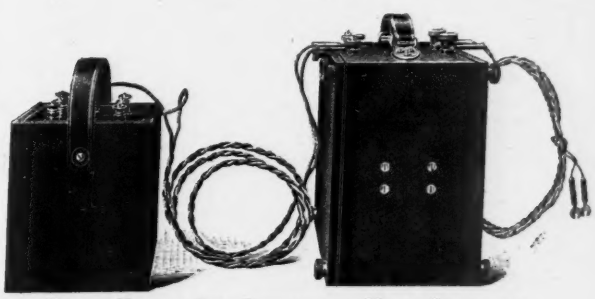
Auckland. Teleph. goods	Value £23
Buenos Ayres. Elec. mat.	9
Calcutta. Elec. machinery	935
Christchurch. Elec. mat.	16
Durban. Elec. mat.	186
Melbourne. Elec. goods	51
Rio Janeiro. Teleg. mat.	188
Shanghai. Elec. goods	88
Sydney. Elec. goods	35
Total	£1,531

Fire Alarm Installations.—The May-Oatway Fire Appliances, Ltd., have recently given out contracts for their installations as follows:—For the premises of Messrs. J. & P. Coats, Ltd.: Contracts 1, 5 and 6, National Telephone Co.; contracts 4 and 7, Messrs. Wylie & Lochhead, Ltd.; contracts 2 and 3, Messrs. J. Kilpatrick & Son. The work at Moss's Empire Theatre, Edinburgh, and on the premises of Messrs. J. Taylor & Son, Edinburgh, is in the hands of Messrs. Wm. Douglas, Ltd.; Messrs. Troup, Curtis and Co. are to equip the premises of Messrs. Stapley & Smith, London; and Messrs. McIntyre, Hogg, Marsh & Co., London; and the Private Wire Installation Co. is to carry out the requisite work on the premises of Messrs. W. L. Lucas & Co., London.

Trucks for Sale.—The Isle of Thanet Electric Tramways and Lighting Co. is offering 20 pairs of maximum traction trucks for sale. See our advertisement pages to-day.

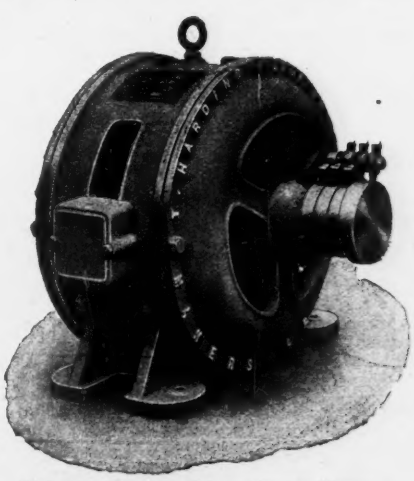
Kelvin Testing Set.—We illustrate herewith a new form of motor-generator intended for use with Lord Kelvin's well-known insulation testing set. In the past, primary or secondary cells have been used, but these must necessarily be small if the requisite number of cells to give the desired voltage are to be supplied in a compact form. Although these cells will give satisfaction and work well for a considerable time, provided they are properly looked after, trouble is sometimes experienced due to the box containing the cells being left in a damp situation, thus causing rapid deterioration. The instrument as now put on the market by Messrs. Kelvin & James White, Ltd., is in a very compact portable form, and consists of a 6-volt storage battery of 15 to 20 ampere-hours capacity, and a small motor-generator which is driven from the storage battery. The capacity of the 6-volt battery being large, no trouble is experienced due to surface leakage or local action.

The field of the motor-generator consists of permanent magnets, but these have extra coils fitted which are used as a starting resistance, so that the magnets are re-magnetised every time the motor is started up. The motor-generator is arranged to give 300, 400 or 500 volts, this allowing tests to be made on line at the actual working pressure. The voltage of the generator can, of course, be varied either by the starting resistance, or by altering the number of cells driving the motor. When used under any particular conditions, however, the voltage of the generator remains absolutely constant, even when tests are being made on a short circuit, as there is always the resistance of the galvanometer (50,000 ohms) in circuit. The size of the motor-generator is approximately 10 in. × 9 in. × 6 in., and the 6-volt battery 7½ in. × 5½ in. × 4¾ in., and the weights are such that they can be easily carried about.



KELVIN TESTING SET: BATTERY AND MOTOR-GENERATOR.

A New Single-Phase Motor.—Messrs. T. Harding Churton & Co., of Leeds, have recently commenced the manufacture of A.C. motors of the induction type for single-phase circuits. The characteristic features of the polyphase motors, which have for some time been made by this firm, have been embodied in their single-phase motor. We are informed that very high efficiency and power-factor are obtained, and that the motors run particularly quietly and with comparatively slight increase in temperature. The starting power, too, is said to be highly satisfactory. When the motors are provided with rotors of the short-circuited type, the starting is effected by means of a throw-over switch, the motor being started by auxiliary coils which are cut out by the switch when the motor has attained full speed. This arrangement answers well whenever the motor is not required to start on load. When a large starting torque is required, the rotors are wound, the free ends of the windings being connected to slip-rings. The starting switches for such motors are provided with a multiple-contact switch and resistance, the resistance being inserted in the rotor windings when starting, and gradually cut out as the motor runs up to speed. This resistance may also be used for regulating the speed of the



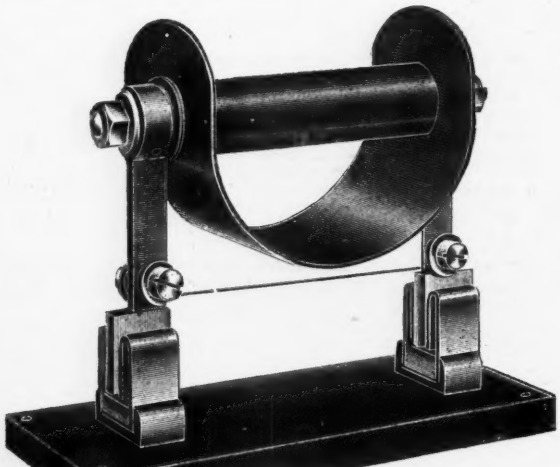
HARDING CHURTON SINGLE-PHASE MOTOR.

motor when required. The end-shields are capable of being turned round to enable the motor to be fixed to floor, ceiling, or wall, as required, and the bearings are provided with oiling rings. The terminals are arranged on one side of the motor and protected by a neat cast-iron cover. We understand that Messrs. Churton & Co. have already supplied, and have on order, a considerable number of their alternate-current motors of various sizes up to 30 H.P. The motors are made in sizes ranging from 1 to 70 H.P., particulars of which are given in the makers' list No. XIX. just issued.

Electrical Fittings.—Messrs. Ward & Goldstone, of Dutton Street, Strangeways, Manchester, send us particulars of several of their electrical specialities, among which the "Olaf" fuseboard and fuse carrier are prominent, as samples of high quality

"Olaf" Fuse-carrier.

workmanship. The novelty of this board is in the fuse carrier heavy clamping nuts. It is provided with alternative channels (in (prov. prot.), which is constructed with solid metal tongues and and out of sight) for the fuse, and for 500-volt circuits, the arrangement permits of 5½ in. length of fuse wire being inserted. The



"Guardian" Hand-shield Fuse.

firm also make the "Guardian" hand-shield fuse, which is recommended for work involving high voltage and current, and a lavatory bolt switch of improved design, a small plunger switch being fitted on the door frame, in line with the bolt on the door, and being

Lavatory Bolt Switch.

operated when the bolt is shot home after closing the door. The firm are manufacturers of cables, watertight fittings, switchboards, &c., full particulars of which are enumerated in their supply lists.

Auction Sale.—On June 15th, at Bermondsey, Messrs. P. Huddleston & Co. are to sell the stock of an electrical engineer by auction. Some particulars are given among our advertisements to-day.

Catalogues and Lists.—The Temperley Transporter Co., of 72, Bishopsgate Street Within, E.C., have issued their 1904 catalogue. This is an excellent production, containing illustrations and descriptive matter of the numerous applications of the transporter to wharves, railway sheds, warehouses, goods yards, generating stations, gas works, factories, special vessels, and apparatus for coaling war and merchant ships, both at sea and in port. Those who contemplate a convenient and efficient transporting installation cannot do better than study the convincing matter contained in the above catalogue.

Section II. of their catalogue of electrical instruments has just been received from Messrs. Nalder Bros. & Thompson, Ltd. It is devoted to their well-known dead-beat moving coil ammeters and voltmeters, and has been revised and extended throughout, a number of new features being included. Some introductory notes briefly state the great progress which has been made in the business since 1896, and a list is given of some of the more important authorities for which the company has manufactured. The particulars, such as code words, prices and standard ranges are plainly detailed in tabular form, illustrations, dimensional and general descriptive data being also given. Sector and edgewise instruments, portable testing sets, shunts, motor-car instruments, typical scales, and interior views of the works of the company at Dalston are included.

From Messrs. Griffiths Bros. & Co., of Bermondsey, we have received a circular giving particulars of some of their special enamel preparations for machine finishing.

As the number of single-phase alternate current circuits having a periodicity of 60 is on the increase, the Langdon-Davies Motor Co., Ltd., of Southwark Street, S.E., have got out a small folding pocket price list of motors suitable for that periodicity.

Messrs. Monte-Callow & Co., of Ludgate Broadway, E.C., have issued a revised price list for 1904, of their "Perfecta" starters, regulators, and controllers.

The Electrical Co. has sent us a list containing copies of a number of recent testimonials received from borough electrical engineers respecting the results obtained with the Nernst lamp used for street lighting.

A new 16-pp. illustrated pamphlet (No. 68) has been issued by the Berliner Telephone Manufacturing Co., quoting reduced prices for a number of their now well-known telephone instruments.

Messrs. W. H. Bailey & Co., Ltd., of Salford, have sent us a copy of their 28-pp. catalogue of safety valves and alarms.

The British Westinghouse Co.'s latest publication is No. B 1,080, and it describes the No. 200 tramway motor. No. B 1,072, issued a short time ago, detailed the company's No. 90 M tramcar controller.

Several new illustrated lists have just been issued from the press by Messrs. Holden & Brooke, Ltd. They are: No. 67 describing the "P.S." (protected seat) valve; No. 66 particularising their motor-wagon injector embodying the "P.S." valve; and a small leaflet devoted to the Brooke's separator.

The Mirrlees, Watson Co., Ltd., of Glasgow, have sent us a description of their surface condensing plant (and tests thereon) supplied for the British Thomson-Houston Co.'s works at Rugby. A note follows of some of the more important condensing plants which either have been, or are being, installed by the company for power supply and traction companies. The list is contained in a cover admitting of the filing of other lists as issued by the company.

Mr. John Jones, of Carlyle Works, Chelsea, in his "A" list just received, gives numerous illustrations and prices of his patent cast-iron drainage fittings, manholes, and manhole covers. One of the specialities is a patent ventilating cover for pavement, roadway, and other electric main inspection chambers.

France.—La Société des Etablissements Postel-Vinay, of Paris, the makers of the Postel-Vinay electric motors, have increased their capital from £120,000 to £280,000.

Brush Contracts.—The Brush Electrical Engineering Co. has secured the following contracts:—

Pietermaritzburg Corporation.—Six completely equipped electric tramcars (with B.T.H. equipments); one watering car (per Westinghouse Co.).
County of London Electric Supply Co.—Forty-two 25-kw. transformers.
Mr. W. M. Murphy.—15 trucks for Paisley tramcars.

German Imports and Exports of Electrical Machinery.—The exports of electrical machinery from Germany continue to show a steady upward tendency, the returns for the three months ending with March last indicating that the shipments during that period amounted to 3,434 tons, which compares with only 3,026 tons in the corresponding quarter of last year. There has also been a slight increase in the imports of foreign electrical machinery into Germany—from 156 tons in the first three months of 1903 to 298 tons in the quarter ending with March last.

Private Telephones.—The contract department of the National Telephone Co. has lately set up private telephone installations for the Lambeth Board of Guardians; for Ashton's Library, Old Bond Street; for Messrs. Shaw & Sons in Fetter Lane; for Messrs. Fuller's new tea rooms in Regent Street; and has supplied 73 metaphones at St. James's Court, Buckingham Gate, to be fixed in conjunction with the various passenger lifts.

Paint Solvent.—We have received a sample of Eberson's "V. and P." solvent, a solution which is stated to be a perfect varnish and paint remover, and which, on account of the extreme facility with which such operations can be conducted as compared with the "scorching and scraping" method in use hitherto, is recommended to the notice of all those engaged in this class of work. The "V. and P." solvent is supplied by Messrs. John Mathews & Co., of Hatton Garden Works, Liverpool.

Bankruptcy Proceedings.—At the public examination of David Todd Cameron, electrical engineer, of Saltash, at Stonehouse Bankruptcy Court, on June 1st, the Official Receiver stated that the business appeared to have been properly conducted, and the books were well kept. The business done amounted to under £100, and that was not very remunerative owing to the cutting of prices by the keen competition in the district. The examination was closed.

At Liverpool Bankruptcy Court on June 2nd, John Jas. De Lacy, and Howard Kyan De Lacy, trading as De Lacy Bros., electrical engineers, of 38, Old Hall Street, Liverpool, were publicly examined. It was stated that the statement of affairs had not been filed. Owing to the illness of one of the partners, the examination was adjourned until July 16th.

Robert Fyfe Barr, jun., electrical and engineers' furnisher, the sole partner of the firm of Brown, Scott & Co., 196A, St. Vincent Street, Glasgow, was examined before Sheriff Substitute Fyfe in the County Buildings, Glasgow, on June 2nd. Bankrupt stated that he started business in July, 1902, along with Mr. Brown Scott, and Mr. Scott was in the business till February 4th, 1903. He then retired from the firm, which was formed for the wholesale supply of electrical material. At the start bankrupt contributed £50 to the business, while Mr. Scott put in nothing. Bankrupt got the agency for the Renewable Electric Lamp Co., in connection with which he expended some capital and labour in making a connection. That company, however, went into liquidation just as he was beginning to realise some profit for his work. On August 1st, 1903, he assumed as partner, a Mr. Woodford; the partnership subsisted till October 24th, when it was dissolved. Mr. Woodford did not fulfil his obligations under the agreement, and bankrupt refused to accept him as a partner. On December 23rd Mr. Kemp became a partner, but he did not begin business because he did not think the work was congenial to him. The business was at this time removed to 196A, St. Vincent Street. Bankrupt supplied various sums—£50, £25, &c.—from his own private banking account in order to keep the business going. He found himself in difficulties over a case in the law courts. His failure he attributed to many causes:—Having to remove so often; his loss on the Nernst lamp; and what he dropped on the failure of the Renewable lamp. In answer to further questions, bankrupt said there had been a great many failures in his line of business, he having been concerned in no less than five. There was an action against him for the price of a dynamo, which he lost. To these causes he attributed his present position. But for the expenses in litigation he would have been able to clear off a great number of his debts. The statement of affairs showed:—Liabilities, £713 12s. 1d., and assets £242 9s. 5d., a deficiency of £471 2s. 8d.

Alexander Scott Johnstone, sole partner of the firm of A. S. Johnstone & Co., electrical engineers, 57, Hope Street, Glasgow, was examined in bankruptcy before Sheriff Substitute Boyde, in the County Buildings, Glasgow, on Monday. Bankrupt stated that he commenced business in October, 1901. His capital amounted to £200, of which £100 was spent in furnishing. He had little experience of the trade of an electrical engineer before he started. He was the manager for a firm, who supplied everything, in South Africa, and on coming home to this country he set up on his own account. He took his brother, who was a practical man, into the business to assist him, and paid him 35s. per week, and afterwards £2 per week. He took general contracts for electric lighting work. He made profits, but he had also some losses on his contracts. The statement of affairs showed:—Liabilities, £1,692 17s. 2d.; assets, £232; a deficiency of £1,416 17s. 3d. Bankrupt attributed his losses to various causes—to his stockbroking transactions during 1901 and 1902, through the fall of South African and West African shares; loss of £400 on the Nernst lamp; a cashier who bolted with £120, and the loss of about £260 on bad debts. All these items made up his deficiency. He first knew that he was in a state of insolvency in January last when he was pressed by one of the creditors. He had never been in partnership, and had produced to the trustee all the books of the firm. He was not made bankrupt before his sequestration, and he had given no preferences to any of his creditors.

Dissolutions and Liquidations.—Creditors of the Dover Electricity Supply Co. must send particulars of their debts, &c., to the liquidators, Park Street, Dover, by June 24th.

Mr. E. T. Oubridge, of 170, Sandhurst Road, Catford, has ceased to be a partner in the Southern Electrical Accessories Co. (4, Newington Causeway, London). The business will be continued under the same style by Messrs. F. W. R. May and E. G. K. Calder.

Mr. Alfred Riley, the liquidator of O. Berend & Co., Ltd., has issued his statement of affairs at the date of the declaration of the first and final dividend of 2¾d. in the £. The costs of the winding-up were considerably increased by legal proceedings brought on behalf of the debenture-holder, and by the action of certain creditors who claimed to be entitled to preferential payment, and whose claims were disallowed.

Belliss Engine Contracts.—The following contracts have been placed with Messrs. Belliss & Morcom, Ltd.:—

For Wolverhampton destructor, by Thos. Parker, Ltd., two 180—190-H.P. engines for direct coupling to Parker dynamos.

For Wolverhampton Corporation, one 430—475-H.P. engine for direct coupling to a 300-KW. generator.

For Anchor liner *Caledonia*, by W. C. Martin & Co., one 100-H.P. engine for direct coupling to Siemens dynamo.

For Madras Tramways Co., Ltd., by the E.C.C., one engine for direct coupling to an E.C.C. 300-KW. generator.

Trade Announcements.—Mr. Andrew Brown, of 110, Cannon Street, E.C., has sent us a catalogue detailing the perforated metals and dynamo stampings of Messrs. Franz Meguin and Co., Ltd., for whom he is sole agent for the United Kingdom. We note that the equivalents of the English and German zinc gauges are given in decimals of an inch and also in millimetres with weights per square foot. Mr. Brown has also been appointed London and district agent for Messrs. G. B. Smith & Co., of Craighall Iron Works, Glasgow.

Messrs. Grindlay, Ross & Co., have removed from 29, Commerce Street, to 79, Mains Street, Glasgow.

The electrical branch of the Crypto Works Co., Ltd., has been transferred to the Crypto Electrical Co., 3, Tyer's Gateway, Bermondsey Street, London Bridge, S.E., to which address all communications relating to orders should be sent. Current accounts, due to or by the Crypto Works Co., Ltd., must be paid, or rendered, at the office of that company at 29, Clerkenwell Road, E.C.

Messrs. J. and A. Anderson have removed to more commodious premises at 231, St. Vincent Street, Glasgow.

In order to deal with increasing business, Messrs. Pickering and Co., of Edinburgh, have removed to larger premises at 95, 99, and 101, Broughton Street, where they hold a very large stock of cables, all electric accessories, &c. An excellent showroom has been fitted up, showing over 1,000 different designs of electroliers, brackets, &c.

Owing to increasing business, Messrs. Spearing & Stark have removed from 107 to 109, Merton Road, Wimbledon.

Messrs. Hodgson Wright & Wood, of Halifax, have appointed the firm of Messrs. Drewett & Hood, of 26, Bath Street, Bristol, and 180, Fleet Street, London, as their sole representatives for the sale of continuous current motors and dynamos, &c., for the whole of the south and west of England.

The Electrical Trades Engineering Co. has removed to 22, York Place, Baker Street, W.

Book Notices.—"Radio-Activity: an Elementary Treatise from the Standpoint of the Disintegration Theory." By Fredk. Soddy, M.A. London: The *Electrician* Printing and Publishing Co., Ltd.

"Quarterly Bulletin of the American Institute of Architects." October 1st, 1903, to January 1st, 1904.

"Radium and other Radio-Active Elements." By L. A. Levy and H. G. Willis. London: Percival Marshall & Co. 2s. 6d. net.

"Africa and National Regeneration." By E. F. Chidell. Second edition. London: Thos. Burleigh. 1s.

"Modern Electric Practice." By Magnus MacLean. Vol. III. London: The Gresham Publishing Co. 12s. 6d. net.

"Electric Lighting for Amateurs." The *Model Engineer* Series, No. 22. Edited by Percival Marshall. London: Percival Marshall & Co. 6d. net.

Raworth's Traction Patents.—We understand that orders have been received during the week for one demi-car with regenerative control for the Glossop tramways, and for three new cars (full size) for the Scarborough tramways. The number of corporations and companies that have decided to introduce regenerative control is now raised to ten.

Curtis Turbines for Japan.—The Tokyo Railway is constructing a tramway system in Tokyo which is to be operated by electricity. It will be one of the most up-to-date plants of its size in existence. It has been decided to use turbines for the generating plant, and the order has been given for four 1,500-KW. and two 500-KW. Curtis turbine units, together with the necessary switch-gear, and 800 G.E. 54 motors for the equipment of the tramcars.

Asbestos Tubes.—From Cresswell's Asbestos Co., Ltd., of Bradford, we have received a sample of asbestos tubes for electrical requirements. The wall of the tube is compact and hard, and capable of withstanding a great pressure. The tubes possess a high degree of non-conductivity of electricity, as well as of heat, and are, of course, fire-proof.

LIGHTING AND POWER NOTES.

Aston Manor.—Some 75 burgesses have petitioned to be received by the Council, with a view to settling an alleged grievance in the matter of charges for energy. It is claimed that the misunderstanding has arisen through the consumers wrongly reading their meters.

Barking.—The U.D.C. has decided that the tramway department shall be charged the same rates as private consumers, for power and light.

Birkenhead.—The T.C. has resolved to apply to the L.G.B. for sanction to borrow the sum of £20,000 for feeder and distributing cables, electric meters, &c., estimated to be required during the ensuing three years.

Birmingham.—The report of the Electricity Supply Committee on the year's working of the undertaking shows that the number of units sold amounted to 4,367,164 units, compared with 3,737,419 in the preceding year, an increase of nearly 17 per cent. as compared with increases of 10 per cent. and 11 per cent. for the two preceding years. There was an increase of 234 new consumers, an addition of 12,000 lamps of 16-C.P. or their equivalent, and an extension in the mileage of the mains of over 5¼ miles. The output for last year represented about double what it was four years ago when the Corporation took over the concern. As the result of several improvements in the working, and other directions which had been suggested by the engineer, the cost had been

reduced this year to about 1½d. per unit. Although there has been an increased output, a saving of nearly £1,000, or about 10 per cent. on the coal bill, has been made, due to less fuel being consumed. Under "Repairs and Maintenance and Renewal of Works," there is a saving of nearly £1,000 shown, and in the distribution a small saving of £200. A gross profit of £36,939 is shown. The charges for interest on sinking fund were £26,527, leaving a net profit of £10,412, as compared with £6,788 last year. The whole of the surplus has been carried to the reserve fund, making the balance to its credit £37,613. The increase in receipts only amounted to £2,000, owing to the reduction made in the price of energy in July last.

Blackburn.—The T.C. has fixed the price of energy for lighting at 4d. per unit on the flat rate, or 6d. and 3d. on the rebate system. For power the charge will be 1½d. per unit for the first 1,500 units per quarter, and 1d. per unit beyond. Meter rents are to be abolished from July 1st.

Bolton.—The T.C. has reduced the prices for energy to:—Lighting, 4d. and 1d., maximum demand, first three hours; power, first 1,000 units per quarter at 2d., and all in excess, 1d.; tramways, subject to the consent of the B. of T., 1·10d. per unit. At a recent meeting it was stated that the output for the past year was 5,056,898 units, an increase of over 1,250,000. The gross revenue amounted to £39,309, an increase of £5,228 on the previous year, and the cost of generating to £14,914, the gross profit being £24,395, or an increase of £3,588. There was a net profit of £7,480, and it was proposed to credit £6,818 to the relief of the rates.

Bredbury and Romiley. — Recently the U.D.C. approached the Stockport T.C. on the E.L. question. In reply, it was pointed out that the proposal to take energy from the tramway trolley wires would not be satisfactory for shop and street lighting. It was also pointed out that the cost of extending the cables to Bredbury would be greater than that of a small station. Regarding the transfer of the E.L. order, the Corporation intimated that it was not prepared to consider the matter unless it could be shown that the undertaking would pay within a reasonable time, and it would require a guarantee that a sufficient number of persons would take a supply.

Colchester.—The T.C. has reduced the price of energy as under:—Up to 100 units per quarter, 4d.; exceeding 100 units, up to 500 units, 2¾d.; exceeding 500, 2½d., with a discount of 5 per cent.

Coventry.—The Corporation has given instructions to prepare a scheme for laying mains in the Hill Fields district; the plans and specification for the extension of the engine house have been passed, and tenders are to be obtained.

Devonport.—The T.C. has reduced the price of energy for power and heating to 2½d. per unit.

Dundee.—The T.C. has declined to entertain a discriminating charge for intermittent power consumers, and on the recommendation that two large motors intermittently used by a consumer (which it is claimed affect the steadiness of the light in the district) shall be disconnected, it has been decided to defer the matter.

Ealing.—The result of the working of the electricity undertaking for the year ended March, 1904, shows a gross profit of £12,142, and a net profit of £3,838. All losses are now stated to have been cleared off and £2,000 carried to reserve fund. The T.C. has resolved to reduce the prices of energy to consumers as follows:—Lighting, 5d.; or during the six summer months, 7d. and 2d. half-hour maximum demand, and during the six winter months, 7d. and 2d. 1½ hours maximum demand; churches, 4½d.; heating, 2½d.; power, 2½d. to 2d. per unit. Slot meter rents are to be abolished, but no reduction in the rate of 6d. per unit through these is to be made.

Eton.—A report has been presented to Eton U.D.C. respecting the cost of pumping at the sewage works by electricity during the past year. The expenditure was £372, against £494 when steam was used, and this in spite of much additional pumping owing to the recent floods. During the year 21,864 units were used, 6,000 being at 3d., and the rest at 1½d.

Faversham.—The supply of energy for lighting was to be commenced by the T.C. yesterday. The scale of charges is 6d. per unit for lighting; 3d. per unit for power (over 2 KW.), with meter rents of 1s. per quarter up to 25 8-C P. lamps, and 1s. 6d. per quarter up to 50 lamps.

Felixstowe.—The L.G.B. has forwarded to the U.D.C. sanction to raise a loan of £14,160 for the purchase of the undertaking of the Suffolk Electricity Supply Co., and for extensions of plant. In all £17,160 was applied for, and the balance is reserved until the Council finds it necessary to raise that sum, *i.e.*, when the company can show a profit of 6 per cent.

Folkestone.—The T.C. has declined to accept the offer of the electric lighting company at £18 per annum for street arc lamps, unless they are lit all the year round.

Germany.—A 1,000-H.P. steam turbine is about to be added to the plant at the municipal electric light station at Krefeld. The establishment of a municipal electric light station in the town of Bad Kissingen has been decided upon.

Golborne.—The U.D.C. has asked the Lancashire Electrical Power Co. what facilities they will give it for taking energy in bulk at a later period, if the Council consents to the company supplying customers in the district.

Handsworth.—The U.D.C. has decided to proceed with its lighting scheme and to put down mains in the principal thoroughfares. A site for the generating station has been secured in Piers Road, and it is hoped that energy will be generated there before the end of this year.

Horsham.—The electrical engineer, Mr. W. B. Morgan, has submitted his annual report of the second year's working. Consumers had increased 53 per cent. and lamp connections 43 per cent. Considerable extensions in plant and mains were made during the year. The increase of units sold to private consumers was 31 per cent. The accounts show a total deficiency at the present time of £1,258, after paying off £796 on account of principal.

Hull.—At the Council meeting held on the 2nd inst., the motion of the E.L. Committee recommending a supply of energy to the N.E. Railway Co., for not less than 1,000,000 units per annum for three years, at 1½d. per unit, for a 27 per cent. load factor, and to Messrs. Reckett & Sons, 500,000 units per annum for five years, at 1½d. per unit, for a 33 per cent. load factor, was under discussion, and after considerable adverse comment by unappreciative members, was finally agreed to. We congratulate Mr. Bell on his acquisition and sympathise with him in his difficulties.

Keighley.—The T.C. has applied to the L.G.B. for a loan of £11,500 for E.L. purposes.

King's Norton.—The B. of T. has deferred the question of revoking the E.L. order for another three months. The U.D.C. is negotiating for the working of the order.

Leyton.—The U.D.C., on the 7th inst., decided to ask the L.G.B. to sanction a loan of £300 to install electric light in the Newport Road school.

Lisburn.—The scheme for the proposed electric lighting of the town has been abandoned.

Liverpool.—The T.C. has applied for a loan of £400,000 for electricity purposes.

Liverpool Docks.—The Works Committee of the Mersey Docks and Harbour Board has recommended that the new entrances to the Brunswick Dock be lighted by electricity, and that certain work in connection with existing lights in the locality be carried out at a total estimated cost of £1,150.

Middlesbrough.—The financial result of the past year's working of the electrical department has been a profit of £534, as against a deficit of £454 in the previous year.

The Committee accepted tenders amounting to £3,370 for the buildings connected with the extension of the generating station.

Middlesex.—The C.C. last week received communications from the B. of T., stating that it was not intended to proceed with the Acton E.L. prov. order, and that it had decided to grant the Hampton Wick and District E.L. prov. order.

Newbiggin.—In response to a letter by the U.D.C., a representative of the Northern Electrical Supply Co. will inspect the district shortly, with a view to arranging for an electric supply.

Nottingham.—The Electricity Committee of the Corporation, in the annual report, states that the demands for electricity have steadily increased, and extensions have been carried out from time to time to meet the requirements of new consumers. The whole of the capital sanctioned by the L.G.B. has been expended, and the Committee has, with the approval of the Council, applied for consent to raise a sum of £100,000 to provide for further extensions of the undertaking. The income during the year was £71,854, and the expenditure £36,978, the balance carried to the net revenue account being £34,875. Up to March 31st last £29,320 had been expended in repayment of loans. The reserve fund, towards which £6,541 13s. 7d., was devoted during the year, now stands at £22,022 12s. 6d. In the course of his report to the Committee, the electrical engineer stated that the total horse-power installed at the three generating stations is as follows:—Talbot Street Station, 8,925 H.P.; St. Ann's Power Station, 4,200 H.P.; Eastcroft, 480 H.P.; total, 13,605 H P. The number of 8-C P. lamps, or their equivalent, connected up on March 31st was 239,366, as compared with 208,306 at the end of March, 1903. The number of motors connected to the mains has increased from 392 in 1903 to 498 in 1904, and the total horse-power from 1,346 to 1,776. The number of units sold during the year for various purposes was as follows:—For lighting purposes, 3,285,986; for power purposes, 1,047,223; for tramway traction, 3,768,601; total, 8,101,810. The Committee had asked Dr. A. B. W. Kennedy, of Victoria Street, Westminster, to make an inspection and report on the undertaking generally, and his report was very satisfactory.

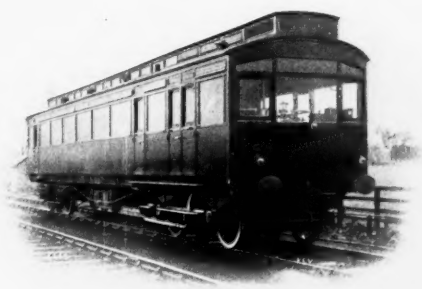
St. Helens.—A report presented to the T.C. last week shows that there was a net balance of profit on the working of the electricity undertaking last year of £2,600, as compared with £576 in 1903. The working cost has been reduced to 0·55d. per unit, and the total cost to 0·78d. per unit.

(*Continued on page* 959.)

PETROL-ELECTRIC MOTOR COACHES ON THE NORTH-EASTERN RAILWAY.

To those who have studied the problems connected with the efficient handling of local traffic, the recent developments in connection with the North-Eastern Railway at Newcastle and Hartlepool are of exceptional interest.

The suburban traveller and his requirements were not



Petrol-Electric Motor Coach.

fully appreciated until the advent of the electric tramcar, with its cheap fares and frequent services; but the inter-urban extension of tramways, frequently in parallel lines to the railways, has moved several of the larger railway companies to energetic action, and among them notably the above company, which until a few years ago had a practical monopoly of the north-east coast traffic, in the absence of railway and tramway competition.

As regards their branch from Hartlepool to West Hartlepool, the company has introduced a service of petrol-electric motor coaches, which are of the ordinary bogie saloon type,

Interior of Coach.

with clerestory roof, 52 ft. long over headstocks and 7 ft. 11 in. wide inside, and with a working weight of 35 tons each.

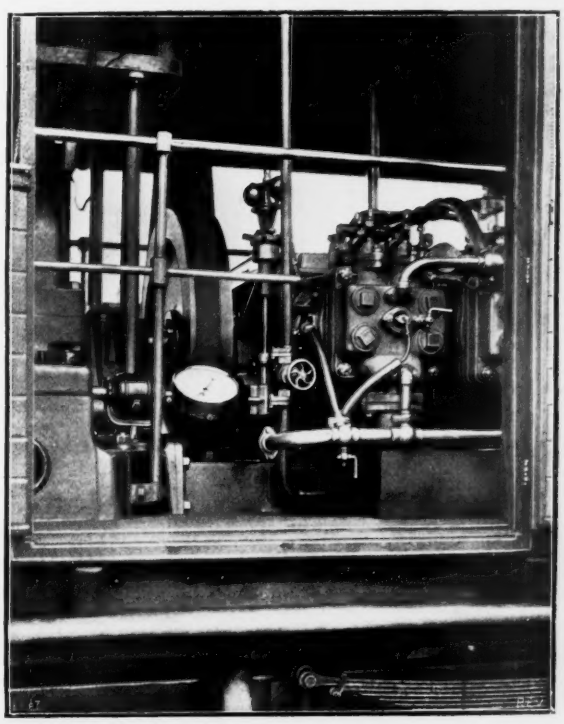
Each coach is divided into three compartments, the forward one containing the petrol-electric generator, switchgear, controlling and braking mechanism for operating the coach from that end. Between this and the centre, or passenger compartment, is an entrance gangway; the rear compartment contains the controlling and braking mechanism for operating the coach from that end.

Seating accommodation is provided for 52 passengers, on reversible upholstered seats, situated on either side of a central gangway.

The coach is lighted by 24 16-c.p. incandescent lamps, worked from accumulators carried under the floor, and the head and tail lamps are also electrically fitted.

The engine compartment contains an 80-b.h.p. 4-cylinder horizontal petrol motor, built by the Wolseley Tool and Motor-car Co., Adderley Park, Birmingham. The cylinders of the motor are $8\frac{1}{2}$ in. diameter × 10 in. stroke, and the normal speed of running is 420 revolutions per minute, which can be accelerated to 480 revolutions per minute for starting the car quickly.

The cylinders are overhung on a stiffly constructed cast iron crank chamber, and forced lubrication is used for all the main bearings. All the valves are mechanically operated by cams on the two camshafts, and these shafts are driven by



Generating Plant in Position.

means of spiral gearing and lay-shafts from the crankshaft, which is of the "two-throw" type of Vickers-Maxim cast steel.

Water-cooled cylinders and valve boxes are employed, a Clarkson radiator and Blackman fan being utilised for cooling the water.

The engine is governed on the throttle, and in addition auxiliary hand throttling is fitted; the ignition is arranged on the high tension system.

The generator, which is direct coupled, is of the separately excited and compound wound direct current type, of 55-kw. output, specially designed for operating over a range of voltage from 300 to 550, with a normal speed of 420 r.p.m.

The field of the generator is split horizontally, and the upper half may be removed if required through an opening provided in the roof of the coach. The exciter is a 3·75-kw. standard 72-volt shunt-wound, belt-driven, multipolar generator, mounted above the main generator and driven from the main crankshaft.

This machine is capable of exciting the main generator and of supplying energy for lighting 30 72-volt 16-c.p. incandescent lamps. The voltage of the machine may be increased to 95 volts for charging the battery, when not required for lighting.

Two Westinghouse No. 56 — 55-h.p. standard railway motors with single reduction gears, ratio 18 to 64, are mounted on the front bogie by means of a nose suspension bar with spring attached to the bogie frame. These motors are series wound, and are of the standard type usually employed for operating heavy high-speed tramcars.

The controllers are of the standard series-parallel tramway type arranged for electric braking, with resistances for controlling the current flowing to the motors at starting, and for graduating the electric brake in stopping. These resistances are mounted under the car.

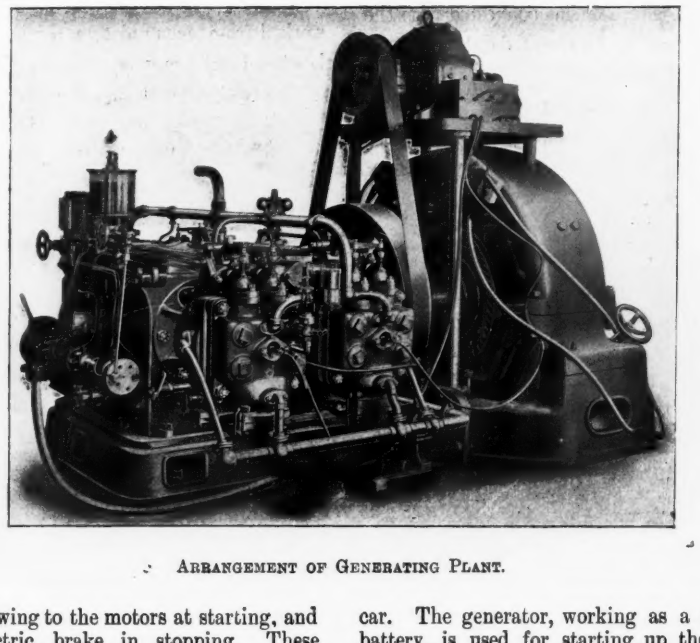
The storage battery consists of 38 cells, assembled in a wooden box suspended beneath the car. Each battery has a capacity of 120 ampere-hours.

The well-known Westinghouse-Newell magnetic brake, adapted for railway working, is fitted to both bogie trucks.

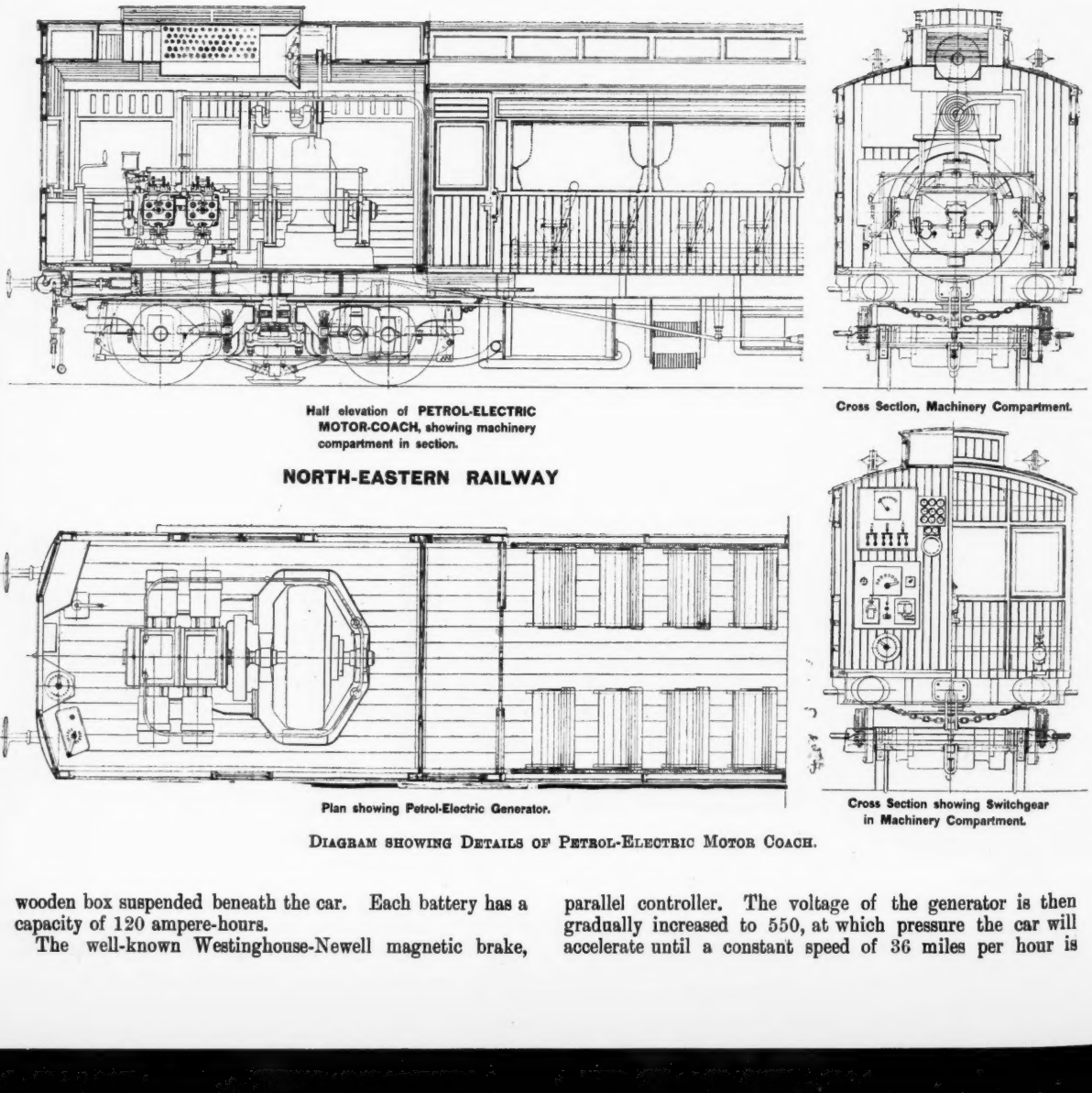
An air compressor, driven by a 1-h.p. electric motor, and automatically controlled, is located on the rear bogie and supplies air for blowing an alarm whistle.

The whole of the electric equipment has been supplied by the British Westinghouse Electric and Manufacturing Co., Ltd., of Trafford Park, Manchester.

In working, the current passes from the generator through an automatic circuit-breaker to the two controllers, the generator voltage being adjusted by means of a rheostat in the field circuit placed near the controller at each end of the car. The generator, working as a motor from the storage battery, is used for starting up the petrol motor. After obtaining normal generator speed and adjusting the voltage to 400, the car is started in the usual way through the series parallel controller. The voltage of the generator is then gradually increased to 550, at which pressure the car will accelerate until a constant speed of 36 miles per hour is



Arrangement of Generating Plant.



Half elevation of PETROL-ELECTRIC MOTOR-COACH, showing machinery compartment in section.

Cross Section, Machinery Compartment.

Plan showing Petrol-Electric Generator.

Cross Section showing Switchgear in Machinery Compartment.

Diagram showing Details of Petrol-Electric Motor Coach.

attained. In stopping the car the controller handle is moved to the "off" position, and then in a reverse direction to apply the magnetic track brake. As soon as the car is brought to a stand-still the generator field rheostat is re-adjusted to give 400 volts, and it is then in a position for restarting. If it is desired to operate the car at half-speed, the voltage may be raised to 550 volts by adjustment of the rheostat, with the controller handle at the full series point.

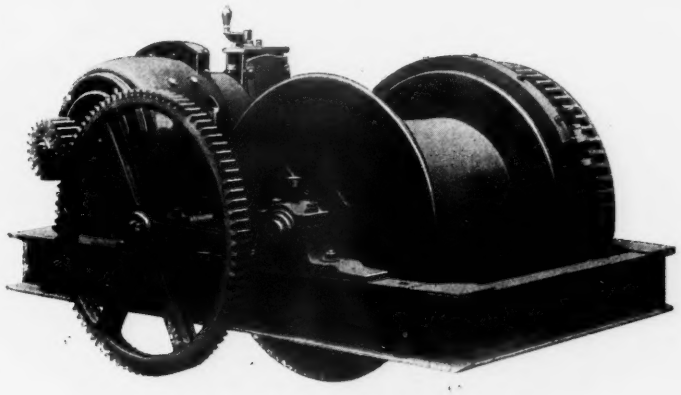
A range of speeds is thus obtainable by varying the generator voltage at two points, viz., approximately half speed and at full speed.

These cars can be put into service at 10 minutes' notice, and carry sufficient fuel and water for a full day's work.

A NEW ELECTRIC HAULING WINCH.

Electric motors, when used for intermittent service, possess really marked advantages over all other motive power agencies. For cranes, hoists, winches, elevators and similar machinery which are not in continual use they are exceptionally well adapted, for they are always ready, consume power only in proportion to the work they are doing, and require no power when not in actual operation. The more irregular the work, therefore, the greater the saving effected by the use of electric power.

The accompanying illustrations give a very good idea of a 6-H.P. self-contained electric-hauling winch which was supplied by the British Thomson-Houston Co., Ltd., of Rugby, to the South Wales Electric Power Distribution Co., Pontypridd. It is suitable for hauling loaded railway trucks of about 12 tons capacity at a speed of 3 miles per hour on a level track.

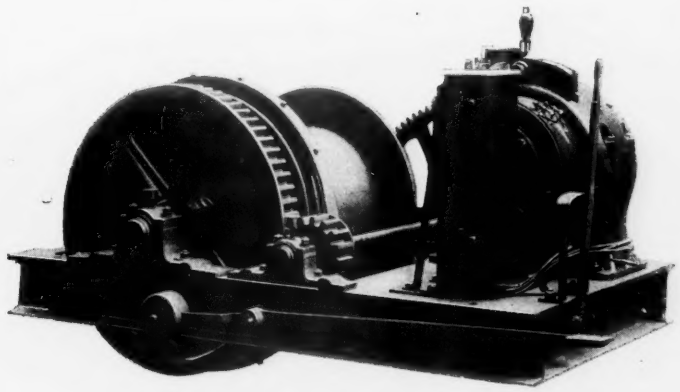


View of Winch showing Drum and Gearing.

The winch consists of a round rope drum 2 ft. in diameter × 2½ ft. wide between the flanges, the ends of which are cast-iron, and the body of steel plate. One end of the drum has a brake path and clutch face cast on, fitted with an all-round band brake and clutch gear. The levers operating the band brake and clutch, and the controller for operating the motor, are placed in a convenient position for the driver.

The drum is mounted on a mild-steel shaft supported in massive cast-iron bearings with gun-metal steps. The spur gearing from the drum shaft to the intermediate shaft is of cast-iron shrouded on one side and accurately bored for their respective shafts.

The intermediate shaft is also of mild steel carried in cast-iron bearings with gun-metal steps.



View of Winch showing Controlling Mechanism.

The spur wheel on the intermediate shaft is of cast-iron with machine-cut teeth.

The drums and gearing are mounted on a channel steel girder bed provided with the necessary facings for the bearings and for the motor and controller.

The motor is of the B.T.H. Co.'s well-known continuous current type, and is mounted upon an extension of the winch bedplate. This type of motor is particularly suited for this class of work on account of its great economy in working, solidity of construction, ease of access to all internal parts and reliability. To ensure simplicity, the number of component parts has been reduced to a minimum, yet nothing essential to the smooth running and the reliability of the motor has been sacrificed. It is totally enclosed and weatherproof, and has a capacity of 5 H.P. at 780 r.p.m. when running continuously at full load with a temperature rise not exceeding 50° C. (90° F.) above the surrounding atmosphere. The motor is capable of giving 6 H.P. continuously for periods of half an hour, and will give 9 H.P. momentarily without undue heating or sparking. It is compound wound, and designed for a pressure of 110 volts at the terminals. The bearings are of the self-oiling type with oiling rings and large oil wells.

The motor is equipped with removable hand-hole covers, so that inspection of the commutator and brushes can be readily effected.

The controller is of the B.T.H. tramway type, with one handle for forward and reverse, and has five running points in either direction.

There should be a splendid field for such winches in the Welsh colliery districts, which are now being opened up for electrical working.

THE DICK-KERR HIGH PRESSURE OIL SWITCH.

The rapidly increasing and extensive application to present day commercial requirements of high pressures for the transmission of power, has brought prominently forward the necessity of providing suitable and reliable apparatus for handling with safety currents at very high voltages.

Soundness in design, and care in construction, are absolutely essential, for the slightest weakness or defect may disable the system of supply and lead to most serious results.

The high pressure oil switches which Messrs. Dick, Kerr and Co., Ltd., have placed on the market possess some novel features, and as they are being largely used on systems at home and abroad, a short account of their construction and method of working should be of interest. The switches are supplied singly or in multiples to suit any number of phases, and can be operated automatically.

The main terminals for connecting the cables are secured to vertical rods which are highly insulated with mica sleeves and porcelain insulators with large creeping surface; they are held in position by substantial insulators securely fixed to a cast-iron webbed plate which is bolted to the cast-iron frame. This plate acts as a cover to the oil box which surrounds the switches.

From the lower ends of the vertical rods depend the

copper jaws which engage the switch blade. The latter is carried horizontally in a heavy porcelain insulator, and attached to a turned steel rod which is secured at the upper end to a crosshead, guide rods, and weight. The switches are enclosed in a large oil box, which may be lowered by means of a winch attached to the frame. The oil box is lined with impregnated material, and fitted with fireproof partitions consisting of marble or other suitable material for separating the various switches, and when the box is fixed in position it entirely encloses the live contacts of the switch. It is also dust proof and oil tight. An oil gauge is fitted to the side of the box by which the height of oil in the box may readily be observed.

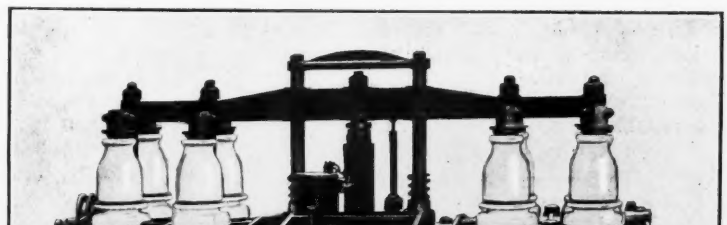
The top of the cast-iron frame is provided with columns for supporting the trip gear, weight, and horizontal crosshead, from which depend the vertical rods which are attached to the switch blades. The trip gear is attached to a series of links which connect up through cranks to the operating handle mounted on the switchboard.

To close the switch, the handle must be forced down until the spring bolt locks. This motion raises the weight and crosshead, and closes the trip gear and switch. The switch may be opened by withdrawing the spring bolt and raising the switch handle. On releasing the handle the trip gear is immediately brought into action, the weight falls smartly on the crosshead, and throws the switch blades out with a quick-break action.

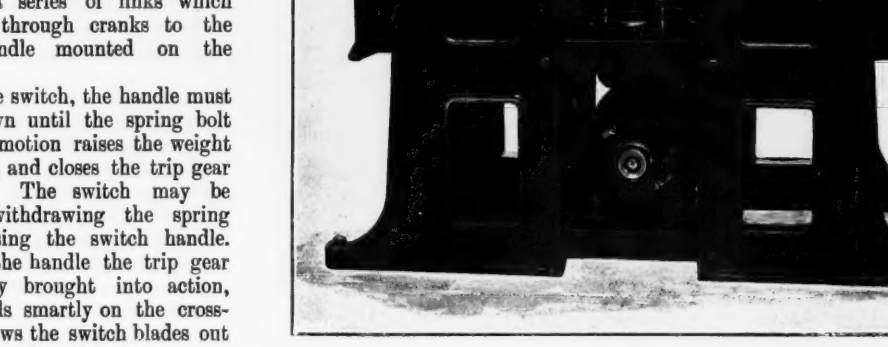
In addition to the ordinary operating handle, each switch is provided with an emergency throw-out. This takes the form of a solenoid attached to the frame of the switch, the armature of which actuates the trip gear. The local circuit for operating the solenoid is closed by a small press-button switch placed immediately above the main switch handle on the board. These switches may be fitted with automatic overload and no-voltage release.

For larger work a special type of oil break-switch, similar in design to the foregoing, is manufactured, which is operated by a motor. This does away with the link and crank gear which connects the switch to the switchboard.

In place of the switch handle on the board, are placed two small press-button switches marked "on" and "off." These are joined up by clockwork and relay through a local conduit which starts and stops the motor. The motor is provided with a fly-wheel and gearing, the gearing actuating a vertical rod which engages the trip gear for releasing the weight placed above the switch frame. The motor and gearing are made in the most compact form, and fitted neatly under the switch frame, while the clockwork and relay are fitted at the back of the switchboard behind the press-button switches.



Motor Operated High-Voltage Oil Switch.



Hand-Operated High-Voltage Oil Switch.

Middlesex Tramways.—On Thursday last week the County Council instructed the solicitor to treat for the property required for the widening of the road in connection with the Acton to Harlesden tramway. A question as to the liability of Messrs. J. G. White & Co., Ltd., contractors for the No. 5 Tramway, to make good portions of the track in the Edgeware Road, which had subsided, was referred to arbitration.

LIGHTING AND POWER NOTES.

(*Continued from page* 954.)

London.—St. Pancras.—A dispute has arisen between Messrs. Oetzmann & Co. and the B.C. as to whether the company and private consumers generally, are not entitled to be supplied at the lowest charges accepted for hospitals, places of worship, theatres, &c., and whether—the Council giving the option of payments on the flat rate or maximum demand—the company are not entitled to a part supply on the flat rate and part on the maximum demand. The company notified the B.C. that, if its demands were not complied with, it would legally test the matter. A special sub-committee has gone into the matter, and decided that the firm's contention should not be acceded to, counsel's opinion being that municipal authorities were entitled to classify consumers, and charge according to the special requirements; but upon this report coming up for adoption by the Council, the chairman of the committee said it would be withdrawn.

The B.C. has resolved that the whole of the arc lamp extensions sanctioned, shall be of the overhanging type, at an extra expense of £1,276. The electrical engineer stated that, in consequence of the increased load in the southern district, it was necessary to lay down an additional feeder at an estimated cost of £2,500. This was agreed to.

It was also resolved to petition for the elimination of clause 6 (1) in the Electricity Supply Bill, fears being expressed that if the clause was passed as drafted, a company might be allowed to enter into competition with the Council in the borough.

Battersea.—It was reported to the B.C. on Monday that the agreement with the County of London Electric Lighting Co., in connection with the E.L. (London) Bill, would be exchanged shortly. The Council's petition against the Bill would be withdrawn when the exchange had been effected. Mains extensions to the estimated cost of £264 have been sanctioned.

Islington.—With the object of reducing radiation losses, the B.C. has decided to add steam valves and modify the arrangement of steam mains, £281; they will also obtain an automatic flue gas analysis recorder, £42; and a motor for the fitting shop. Mains extensions to the estimated cost of £130 were sanctioned.

Woolwich.—A circular letter has been sent to local authorities by the B.C. referring to the East London and Lower Thames Electric Power Bill, the preamble of which had been found by a committee of the House of Commons to be not proved, and suggesting in view of the great importance of the matter, the desirability of united opposition by the borough councils affected if the Bill, as was probable, was re-introduced next session.

Poplar.—The B.C. is to ask the L.C.C. for consent to a loan of £59,000 for electric lighting extensions.

Marylebone.—On Tuesday last the E.L. Supply Committee decided on the principle of a gradual transfer of the business from the company to the B.C., so soon as the latter is ready to supply energy from its own station, and a conference is to be arranged with the company. The company submitted estimates for very considerable expenditure for works, a great portion of which Mr. Wright decided would not be required by the B.C. under its new system. It was decided to agree to the provision of a new battery at North Street, and the company agreed that no more lighting consumers shall be connected at 200 volts, or across the outers of the three-wire system. Mr. Wright has submitted the plans, drawings, and specifications for the new generating station, and advises that tenders should be invited during the present month. It was resolved to treat for the property required for a site immediately the Royal assent is obtained, and sanction will be asked for a loan of £436,500 from the L.C.C. for the new station.

Bermondsey.—The B.C. has passed an estimate of £260 for installing electric light in the stairways and courtyards of the working class dwellings now being erected in Fulford Street.

Newport (Mon.).—The Electricity and Tramways Committee, in its report for the first year's working of the electric tramways, shows that there has been a net surplus of £400. In view of the difficulties and delays, this result is considered highly satisfactory. The total revenue from all sources was £23,653, with a gross profit of £8,120. Sinking fund and interest amounted to £7,720. Some of the lines were not running till July, and bad weather affected the holiday traffic. The amount realised is not so high as that estimated, but the estimate was based upon the figures reached in other places where the cars are, for the most part, run on Sundays. The earnings per car-mile are about 9d.—1d. less than they should be to reach the average. But with everything in full working order next year the cars should be run with a much larger margin of profit. On the lighting side there has been a net loss. The total revenue was £18,166, with a gross profit of £9,370, but after paying interest and sinking fund, £9,595, there is a deficiency of £225. While this result is disappointing, it is hoped that the adverse balance will be wiped off next year and replaced by a profit.

Paris.—The electricity company which supplies the areas on the left bank of the Seine at Paris has decided to extend its generating station at Issy. Four alternators of 600 kw. each are to be installed in place of the original units, the latter being now too small to cope with the increased demand for energy. Each generating set will consist of one Westinghouse single-phase alternator, 3,000 volts, 42 periods, direct-connected to one of the existing horizontal steam engines, which can give out 800-h.p. each. They will be put into service successively, in order not to interfere with the working of the station. The exciting current for each unit will be furnished by a 25-kw. exciter, at 125 volts. Each alternator will be fitted with a special fly-wheel weighing about 7·7 tons. The spider will be cast in two pieces, so that it may be mounted direct on to the shaft of the engine, without removing the bearings. When the extension is complete, the centre aisle of the Issy station will contain ten generating sets, five of which will have been supplied by the French Westinghouse Co. One Westinghouse alternator was installed in October, 1903, on trial; and it is due to the perfect running of this machine that the order has been placed for the four new machines which are now under construction.

A tabular statement has been compiled in reference to the financial results of the Paris electric lighting companies during 1903. The statement, which has been prepared for the purpose of calculating the amount of the tribute to be paid to the municipal council, shows the following figures:—

Company.	No. of consumers.	Receipts in 1903.
Paris Compressed Air	4,840	£266,905
Continental Edison	4,750	215,138
Place Clichy	8,670	167,845
Champs Elysées	8,645	155,244
Eclairage et Force	3,196	120,589
Rive Gauche	5,044	93,975

The legislative scheme for the taking over of the gas supply business by the municipal council, also proposes the assumption of the electric lighting branch, although the question seems to bear more relation to the former department than the latter. At all events, nothing can be predicted as to the ultimate result or as to the conditions which would be imposed upon the companies in the case of a renewal of their concessions, but it is said that if an extension is granted, the city authorities would require the lion's share of the profits, and seek to enforce other onerous conditions.

Penge.—In the extract which we gave last week from the letter received by us from the Blackheath and Greenwich District Electric Light Co., an error inadvertently occurred. The clause ending "that portion of the Crystal Palace Co.'s undertaking *within the Penge district*," should read "within *their* district," meaning, of course, the Beckenham U.D.C.'s district. We regret the error.

Ravensthorpe.—The question of applying for a prov. order for E.L. is being considered by the U.D.C.

Rio de Janeiro.—The directors of the Rio de Janeiro Gas Co., which is either a Belgian or French company operating in that city, state, in the report for 1903, that the Government of Brazil intimated in January of last year the first zone of the town to be lighted by electricity, in accordance with the agreement between the two parties. In July the company submitted a scheme for the establishment of works and the laying of cables for the first zone, and capable of subsequent extension for the lighting of the other parts of the city. Although a period of eighteen months had been fixed in the agreement for the completion of the first works, the company has agreed to finish this section in twelve months, but official delays have hitherto prevented the scheme from receiving the approval of the Government.

Rotherham.—The T.C. has received from the L.G.B. sanction to raise a loan of £14,670 for E.L. purposes.

Runcorn.—The T.C. has applied to the B. of T. for an extension of the E.L. order of 1899, for a further period of two years. The Council is negotiating with a private firm for the leasing of the order.

Southport.—The analysis of the accounts of the electricity undertaking show that the revenue for 1903-4 is £21,589, an increase of £1,629; the total costs, £7,016, a decrease of £581; and the net profit £3,616, an increase of £1,831. The number of 8-c p. lamps connected is 84,186, an increase of 12,522; the number of units sold, 1,757,122, an increase of 100,000 (private supply increase, 108,000; public lighting decrease, 3,000; traction supply, 11,000 decrease, owing to the company using one motor only); the units sold per lamp fell from 14·3 to 13·7, but the average price for lighting has increased from 4·05d. per unit to 4·06d., and for public lighting from 1·62d. to 1·69d.

Stourbridge.—The U.D.C. at a special meeting on 6th inst., after particulars had been given by Mr. Clarke, its electrical engineer, decided to take a supply of energy in bulk from the Midland Corporation for Power Distribution for the lighting of the town. The alternative proposals in connection with their scheme were to supply electricity purchased in bulk and distribute to customers through the Council's mains; and to erect a generating station in combination with the Council's refuse destructor. The capital outlay for the latter was estimated at £15,674, and for bulk supply £6,158. Mr. McLean, of the company, had, it was stated, informed the Committee that the company would be willing to accept from the Council a notice of six or 12 months to discontinue the supply, and should notice to discontinue the supply be given, the company would take over all arc lamps on a basis of 10 per cent. per annum reduction on the net cost, and all motors at a reduction of 5 per cent. per annum on the cost.

Swansea.—The gross profit for the last year's working of the E.L. department amounted to £5,795, and after meeting financial charges, a net profit of £744 remains, which it has been agreed to carry forward.

Warrington.—The Stockton Heath P.C. has consented to the T.C. supplying energy to the parish on the understanding that the price is not in excess of that charged at Warrington.

TRAMWAY AND RAILWAY NOTES.

Aberdeen.—For the past year the revenue of the Corporation tramways from passenger fares amounted to £62,794, or an increase of £12,791 over last year's. The expenditure on electricity and wages amounted to £26,530 3s. 3d. against £15,120 6s. 11d., being an increase of £8,409 16s. 1d. The estimated income for the year was £63,700, and the estimated expenditure £48,938, leaving a balance of £14,762.

Ashton and Stalybridge.—For several months past there has been a complete dead-lock in the negotiations between the Ashton-under-Lyne Corporation, and the Stalybridge and District Tramway Board, as to the running of cars between Ashton and Stalybridge. On the 2nd inst. the Joint Tramway Board decided to close the negotiations, and failing Ashton's acceptance of the terms submitted, to take independent action. The commercial manager was instructed to inform the town clerk of Ashton that the Board would, on and after the 13th, be in a position to run their own cars on the Stamford Street (Ashton) tramways, and the agreement for running their cars would then cease. The Board are prepared to run alternate cars with the Corporation on the terms already submitted by them, viz., an equal service of cars, and each authority to take its own receipts. Failing the Corporation's acceptance of these terms they must cease to run any cars in Stalybridge on the 12th inst., and, in this event, the sub-committee are instructed to make arrangements for the running of the Stalybridge traffic to Scotland Bridge at Ashton by way of Park Road, on the 13th inst. At present the route is occupied by the Ashton Corporation cars exclusively, and there is a quick through service.

Birmingham.—The Tramways Committee have issued their report upon the question of the rearrangement or extension of the existing tramways or the construction of new lines. In preparing the plans the Committee have had regard to the practicability of linking up, by means of new tramways, the existing tramways of the city, so as to provide inter-communication between the various districts, but they have been met with serious obstacles in the way of narrow and congested thoroughfares, which could only be made suitable for tramway purposes at enormous cost. The Committee suggest that a Bill be promoted in the 1905 session to enable the Council to construct tramways along the 16 different routes mentioned in the report. The total length of tramways now proposed reckoned as single track, is about 39¼ miles, and the cost if constructed on the electric overhead system, is estimated at £295,000. This sum is exclusive of the cost of street widening, power-stations, depôts, or rolling stock. The Committee are unable to report at present as to the cost of the necessary street widenings. This will be brought before the Council at an early date, but as a general principle they consider that where a widening is wholly for the purposes of tramway extension the cost should be charged to that department. Where, however, a street widening is probably anticipating or extending a public works improvement, they suggest that the cost should be apportioned between the public works and tramways department. The report is to be submitted to a special meeting of the Council on 14th inst. Our correspondent says that, so far, criticism is against the terminal loops at the city ends of each route, and through communication between the various suburbs is advocated by many.

A somewhat peculiar accident happened last week on the Bristol Road route of electric trams. Two tramcars proceeding in opposite directions swerved so badly that they collided in passing each other, with the result that several passengers on the tops of the cars had bruised fingers. It is officially explained that the rail joints are sinking, and operations have now been commenced to level up the lines.

Blackpool.—The T.C. on Tuesday resolved to substitute 2d. for 1d. as the minimum tram fare, as 1d. does not pay.

Brazil.—The *Diario Official* of May 5th contains a decree approving the draft of a contract to be made between the Ministry of Industry, Transport and Public Works, and the civil engineer, Eugenio de Andrade, for the construction and working for 70 years of a standard gauge electric railway from Rio de Janeiro to Petropolis. The concessionnaire has the right of exemption from import duty on certain articles destined for the construction of the railway as well as on the coal destined for its working. The *Diarios* containing the above can be seen at the offices of the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, E.C.

Brussels.—About six months ago a Belgian syndicate made arrangements for the acquisition of the 50,000 shares held by the Helios Electricity Co., of Cologne, in the Union des Tramways, of Brussels. The agreement was, however, not carried into effect on the ground that the transfer of shares which are not fully paid was contrary to the statutes. It is now announced that a new agreement has been entered into whereby one-half of the total number of shares shall be fully paid by the Helios Co., with, it is said, the assistance of the purchasers, while the remaining 25,000 shares will be transferred to Belgian interests at a later period. The German company is to hand over the shares by a stipulated date, and it will withdraw from the administration of the Union des Tramways on the completion of the agreement.

Darlington.—The new municipal electric tramways were formally opened on 1st inst. Six of the 16 cars which the Corporation has provided were used. The first car was started by the Mayoress, and the second by Mrs. Wilkes.

Dartford.—The U.D.C. has accepted the offer of Messrs. J. G. White & Co., Ltd., for the construction and leasing of the tramways. The track is to be 8½ miles in length, and 12 cars are to be provided at a cost of £8,307. The company will take current from the Council at 2d. per B. of T. unit for the first 100,000 units per annum, 1¾d. per unit from 100,000 to 150,000 units, and 1½d. per unit for all above 150,000 units. The Council will, under the agreement, seek powers for extending the tramways to Swanscombe, the company to construct and lease this line.

Dewsbury.—Major Druitt held a B. of T. inquiry last week at the offices of the Yorkshire (Woollen District) Electric Tramways, Ltd., into the accident which occurred at Dewsbury on May 20th. Arthur Oldroyd, the conductor of the runaway car, in giving evidence, said that, so far as he knew, there had been no trouble with the brakes. Walter Stead, the driver of the runaway car, No. 7, said he had been in the service of the company about 15 months, and had run cars from Dewsbury to Cleckheaton for nine or ten months, and had never had a scratch before the day in question. The car was provided with hand, scotch, and Westinghouse brakes. Going down a hill into Heckmondwike the car did not run properly, and he let out sand. The wheels were inclined to stick. They were new wheels, and he thought by working they would get easier. On the return journey he did not use the Westinghouse brake until he was descending the hill to Dewsbury. There was something stiff, and he had to use plenty of sand. When about half-a-mile from Dewsbury he stopped with the hand brake. He then put the seventh notch of the Westinghouse brake on, and the sixth. It acted, and he then released the car to the fourth, and it shot out. He put out sand, and altered the brake to the seventh notch, but it went faster. He threw the controller to the off position and put the scotch brake on, but there was no effect. John Unerhill, shed foreman, spoke to the car having been in the shed for re-wheeling. He ran it prior to the day of the accident, and also on the morning of the 20th ult. He used the Westinghouse brake, which was in good condition. He saw the car after the accident. The reversing handle was on reverse, the driving handle on the second notch of the brake, and the canopy or automatic switch off. The driving handle was bent. Subsequently the inspector examined the damaged car. His report is expected to be issued in a few weeks.

Falkirk.—The T.C. is going to take a plebiscite of the ratepayers on the question of the running of the electric tramcars on Sundays. The syndicate which proposes to run the cars has intimated concessions which meet almost all the objections raised. It is prepared not to run the cars during church service; to give employés a day in lieu of the Sunday; and, what is a most important point, is prepared, when the Council may seek to take over the tramways, to fix the purchase price on six days' profits instead of seven.

Folkestone.—The T.C. has applied to the B. of T. for a prolongation of time for commencing and completing the tramways under the 1901 order.

India.—*Indian Engineering* says that the Howrah Municipality by a majority has decided to accept the offer of the Calcutta Tramways Co. for the construction of tramways on the other side of the Hooghly, and the matter is now before the local Government for final disposal.

Italy.—The report for 1903 of the Italian Southern Railway Co. states that the trials of electric traction by means of overhead conductors at high potential on the Valtellina Railway were continued without noteworthy inconvenience during the year, and it is hoped to obtain results more and more satisfactory with the new locomotives which will soon be placed in service. On the other hand, the directors have been compelled to discontinue the tests with accumulator cars on the line Bologna—Poggio Rusco. Although the administration from the beginning had not great confidence in the practical advantages of the application of this system of traction on ordinary railways, they had not believed it possible to refuse to give to the Government a regular trial of the method. Besides, this proof was associated with a programme for a general study of the different systems of electric traction. It can no longer be affirmed that accumulator automobiles have given unfavourable results from the essentially technical point of view, but as economical service with important tariff reductions had, at the same time, been introduced on the Bologna—Poggio Rusco line, the transportation capacity of the cars proved to be inadequate to the exigencies of the unexpected increase in traffic, and it has been necessary to perfect the service by having recourse to more numerous steam trains in substitution for the electric trains. The result has been an unjustifiable increase in expenses and many difficulties in working the service without any appreciable advantage to the public. It has, therefore, been recognised in agreement with the Government that the trial was an economic failure, and the electric cars were removed from the line in April.

Leeds.—It is reported that on Monday two electric cars collided on the Armley and Bramley section, and caused more or less severe injuries to six persons.

London.—The *Islington Gazette* mentions that a section of tramway working on the Kingsland mechanical surface contact system was on view last week at Messrs. Maple's depository in Camden Street.

Nottingham.—In its annual report the Tramways Committee states that the total income for the year amounted to £128,202, and the expenditure (including contributions to sinking fund, interest on stock and loans, and repayment of loans) amounted to £101,720, leaving a balance of £26,482. Of this balance, £13,000 has been contributed to the general district rate account, and the remainder, amounting to £13,482, carried to the reserve fund which, with interest accrued, amounts to £33,039. So far a sum of £42,417 has been expended in repayment of loans. With a view to reducing overcrowding inside the cars during wet and cold weather, two single-truck cars were fitted with top covers, as an experiment, and to give it a further trial instructions had been given for an additional four cars to be covered. These are being constructed at the Trent Bridge depôt by the tramways staff.

Incorporated with the report is that of the tramways manager on the working of the undertaking during the year, which states that the cars ran 2,512,000 miles, an increase of 394,799 miles over the previous year, but in consequence of the wet and cold summer and the dense fogs during the winter, which in one week reduced the receipts by over £600, and the increased mileage run by the cars owing to improved services, the average receipts fell from 13·06d. to 12·24d. per mile. This, notwithstanding that there was an increase in the receipts of £12,982 4s. 11d. The value of the fares paid by passengers on the cars was as follows:—Tickets issued at 1d., 25,753,842; tickets issued at 2d., 1,811,613; tickets issued at 3d., 311,424; or an average of 1·08d. per passenger. Included in the working expenses for the year, the sum of £23,569 19s. 8d. was paid to other committees, and £7,494 3s. in local rates. Fifty-one cars have been fitted with new and improved lifeguards, complying with the Board of Trade requirements. The cost of covers and lifeguards amounting to £420, was paid out of revenue and charged to maintenance of car bodies and trucks. Seventy-three special cars were engaged for the conveyance of school and picnic parties over various parts of the system, the number of passengers carried thereon being 6,685. The Market Street and Parliament Street route has relieved the congestion of traffic and danger of working cars in both directions through the narrow part of Chapel Bar, though at the same time it has added somewhat to the cost of working owing to the severe gradient and curve in Market Street, and also the additional length of the route as compared with Chapel Bar. The additional cost may, however, be considered a good insurance premium against accidents, the risk having been greatly reduced by the alteration. During the year no fatal accident occurred in connection with the undertaking, and in only one case did an accident result in anything like serious injury to the person concerned, the sums paid in compensation amounting only to £454. Attention is again directed to the great increase in the dangerous practice of passengers mounting and leaving the cars while in motion. The number of cases reported during the year resulting in more or less personal injuries or considerable damage to clothing, was 367, an increase of 124 over the previous year.

In compliance with the request made by the committee to the Board of Trade to reconsider the limitations in the speed of the cars fixed at the official inspection of the various routes, an inspector visited Nottingham on February 5th last, and travelled over practically all the routes in the city. In his report to the Board of Trade recommending that an increase of speeds be granted varying from two to four miles per hour over a considerable portion of the system, he stated: "Since January 1st, 1901, on which date the first section of tramways was opened for electric traction, there have been but few accidents in Nottingham, of anything but a trifling nature, and the Corporation possess a staff of well-trained motormen and conductors. Further increases of speed may, I think, therefore be approved with safety."

Poole.—The arbitration proceedings with regard to the terms upon which the Corporation of Bournemouth are to acquire the undertakings of the Poole and District Electric Traction Co., including the existing line between Bournemouth and Poole, and the powers of construction of a new line between Bournemouth and Christchurch, were adjourned on Monday last week to the 6th inst., when the hearing of evidence was resumed. The company's claim totals £427,619. The arbitrators are Mr. William Eve (nominated by the Corporation), and Mr. R. Vigors (by the company), with Mr. A. S. Lawrence, K.C., as umpire. Counsel representing the Corporation are Mr. Honoratus Lloyd, K.C., Mr. W. L. Williams, and Mr. J. W. Jeeves; while the company are represented by Mr. Balfour Browne, K.C., Mr. Cripps, K.C., and Mr. C. C. Hutchinson. The only witnesses heard (for the company) so far are Mr. J. Stephen Sellon, consulting engineer to the British Electric Traction Co.; Mr. James More, jun., of Edinburgh; and Mr. Robert Hammond.

Preston.—A Manchester paper says that owing to a breakdown in the engine room at the generating station on May 31st, the starting of the new electric cars at Preston, which was fixed for June 1st, was postponed until the end of the week.

Russia.—It is proposed to equip the St. Peterburg street railways with electric power, and the City Council has appointed a commission to ascertain and report if the River Wuoksa is capable of furnishing enough motive power.

A Government Commission has been appointed to inquire into and report on a scheme which has been prepared by M. Vonliarliarsky for the construction of an electric railway between St. Petersburg and Moscow. The municipal authorities of these two cities are reported to be favourable to the project.

Salford.—The tramway receipts are gradually becoming more satisfactory, though still below the records of a year ago. The last week of May they amounted to £5,344, as against £5,607 for the corresponding week of 1903. At its last meeting the Borough Council was asked, in the interests of economy, to reconsider the arrangements for running cars in the outside districts. The number at present run was alleged to be excessive, and their reduction by one half, it was hinted, would give the Corporation £20,000 a year more profit. The chairman of the Tramways Committee (Alderman Linsley), however, pointed out that the long-distance routes, from beginning to end, were the most profitable. The proposed reduction could only result in serious inconvenience to the public. After a long debate the Council rejected the proposal.

Tipton.—At a meeting of the U.D.C. last week it was reported that the tramway company had been called upon to electrify the Dudley Road steam tramway, and that a reply had been received intimating that, owing to the serious subsidence of the and, the electric equipment of the line at the present time would constitute a grave danger to the public, and suggesting the wisdom of waiting until the reconstruction of the road. It was also reported that a deputation from the Council and the Wednesbury Corporation had waited upon the Board of Trade. The clerk read a letter subsequently received from the tramway company, stating that, in view of the statement of the deputation to the Board of Trade, that the inhabitants of the district would rather be without the present steam tramway service, they had seriously considered the question of discontinuing the working of the steam cars at the end of the present month. The present service, it was added, had been carried on at very serious loss to the company for the benefit of the public. The desire of the company was to institute electric traction at the earliest possible date, and the mining engineer had been instructed to make a further report on the subsidences. It was decided by the Council to write to the Board of Trade and also to the company, urging the necessity of electrically equipping the line from Dudley to Cospel End, it being stated that there was no subsidence along this length of road which prevented that being done.

Since the above meeting, the tramways company have issued a notice that the steam tramways will be closed for traffic after the 15th inst., and this action has caused considerable surprise and indignation. A large number of drivers and conductors will be thrown out of employment. The company are having the line surveyed, and will be guided by the engineer's report as to whether they will reconstruct it for electric traction.

TELEGRAPH AND TELEPHONE NOTES.

Swansea Telephones.—It is stated that the telephone system at Swansea is now up to its full complement, and though extensions of the exchange have become necessary, the Corporation has postponed carrying these out for the time being.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1902	
St. Lucia-Martinique	May 7, 1902	
Trinidad-Demerara No. 1	Aug. 27, 1901	
Cayenne-Pinheiro	Aug. 18, 1902	
Anjer-Kalianda	Aug. 2, 1902	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1902	
Tarifa-Tangier	Jan. 18, 1904	
Closed { Nagasaki-Vladivostock	Feb. 15, 1904	
Closed { Port Arthur-Chefu	Feb. 18, 1904	
Foochow-Formosa	Feb. 11, 1904	
Gibraltar-Tangier	May 17, 1904	
Accra-Lagos	June 1, 1904	
Cape Town-Mossamedes	June 1, 1904	June 6
Nagasaki-Fusan	June 7, 1904	
Landlines.		
Seoul-Masampo	Feb. 13, 1904	
Seoul-Gensan	Feb. 13, 1904	
Anju-Ping-Yang	Feb. 25, 1904	
Ninguta-Vladivostock	March 2, 1904	
Dominican lines	May 26, 1904	
Kanburi-Bangkok, *via* Moulmein	June 2, 1904	June 7

The Great Northern Telegraph Co. notifies the interruption of the Japan Korea cable.

The Telephone Purchase Question.—In the House of Commons on Monday, Mr. Lough asked the Postmaster-General whether his negotiations with the National Telephone Co. for the purchase of their system were yet completed, and whether he intended to give notice to terminate the license at the end of this year; and what steps he intended to take to bring the arrangements before Parliament in accordance with his undertaking. Lord Stanley, in reply, said that the negotiations were not concluded, and while they were in progress the hon. member would hardly expect him to make any declaration as to the intentions of the Government with regard to terminating the company's license by notice. He could assure the hon. member that if any arrangement was come to, he had every intention of fulfilling his promise to bring the matter before Parliament for approval.

A further question was asked in the House on Wednesday, and Lord Stanley said that the agreement would first be submitted to a small committee of the House to be reported upon, but he could not say that it would be during the present session.

New Exchange of the N.T. Co.—On Tuesday last the National Telephone Co. gave a Press view of the new Central Battery Exchange which they have put into operation in the Birkbeck Building, Holborn. The Exchange is at present fitted for about 5,000 lines, but has an ultimate capacity of 15,000, and has cost over £50,000.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bridgend.—June 18th. Telephone and fire-alarm installation for the Angelton and Parc Gwyllt Asylums. See "Official Notices" to-day.

Bulgaria.—August 13th. The Municipal Authorities of Phillippopolis are inviting tenders until August 13th for the concession for the electric lighting of the town and for the construction and working of an electric tramway.

Colchester.—June 13th. Electric lighting installation at the car depôt. See "Official Notices" June 3rd.

Deptford.—June 21st. Two 25-KW. steam dynamos, booster and switchboard, for the electric lighting of the new Town Hall. See "Official Notices" May 27th.

Erith.—July 11th. Rails, fishplates and bolts; permanent way construction for the U.D.C. tramways. See "Official Notices" to-day.

Germany.—June 15th. Tenders are being invited until June 15th by the Prussian State Railway Authorities at Bromberg for the supply and erection of an electrically-operated locomotive turntable. Tenders are to be sent to Die Königl, Eisenbahn, Direction, Bromberg, whence particulars may be obtained.

Finchley.—June 20th. One 350-KW. high speed engine and dynamo. See "Official Notices" to-day.

Isle of Thanet.—Electricity meters for the Isle of Thanet Electric Tramways and Lighting Co. See "Official Notices" to-day.

Johannesburg.—July 4th. Cables, conductors, and accessories. See "Official Notices" May 13th.

Leigh.—June 21st. One 350-KW. steam-driven set and switchboards. See "Official Notices" June 3rd.

London.—June 15th. The Metropolitan Asylums Board invite tenders for engineering supplies and electric accessories. Particulars can be obtained at the office of the Board, Embankment, London, E.C.

Loughborough.—June 25th. Cable, switchboard and piping. See "Official Notices" to-day.

Portsmouth.—June 11th. Pump and piping. See "Official Notices" May 27th.

Shanghai.—July 30th. The Municipal Council invites tenders for a 24-mile electric trolley line concession. Particulars from J. Pook & Co., 63, Leadenhall Street, E.C., the London agents of the Council. See "Official Notices" May 13th.

Spain.—June 21st. The Municipal Authorities of Talavera de la Reina (province of Toledo) are inviting tenders until the 21st inst. for the concession for the electric lighting of the town during a period of 4½ years Particulars may be obtained from, and tenders are to be sent to, El Secretario del Ayuntamiento de Talavera de la Reina (province of Toledo).

Spain.—July 15th. The Spanish Ministry of Public Works in Madrid is inviting tenders until July 15th for the concession for the construction and working of an electric tramway between Sarria to the foot of Vallvidrera mountain (province of Barcelona). Tenders are to be sent to El Ministerio de Obras Publicas, Madrid, whence particulars may be obtained.

Stepney.—June 20th. Electric light installation at the Public Baths. See "Official Notices" May 27th.

Stepney.—June 28th. Electric wiring for the public baths. See "Official Notices" to-day.

Switzerland.—June 25th. Tenders are being invited until the 25th inst. by the Swiss Military Authorities at Berne for the supply and installation of 250 lamps and the necessary conductors for the electric lighting of the underground chambers at the Fort of Dailly. Tenders are to be sent to Le Departement Militaire Suisse (Service de Genie, Section des Fortifications), Berne, whence particulars may be obtained.

Walthamstow.—June 23rd. Three Westinghouse gas engines, three C.C. dynamos, and other plant for the electricity works. See "Official Notices" to-day.

Wigan.—June 21st. Twelve bogie cars and equipments. See "Official Notices" to-day.

Wimbledon.—June 17th. Water-tube boilers, economisers, feed pump and pipework. See "Official Notices" June 3rd.

CLOSED.

Acton.—The U.D.C. has placed with the St. Helens Cable Co. a contract for the supply of Dialite insulated cables, &c, amounting to £31,536.

Battersea.—The B.C. has accepted the tender of Messrs. Graham, Morton, Ltd., at £298, for measuring boxes in connection with the coal-conveying plant at the generating station.

Bury (Lancs.).—The Joint Hospital Board has accepted the tender of Mr. Joseph Downham, of Bury, for installing the electric light and telephones in the new diphtheria pavilion.

Colchester.—Messrs. Mather & Platt, Ltd., have lately received a repeat order for the extensions at Colchester, consisting of a 500-KW. dynamo to be direct-coupled to a Davey-Paxman engine. This will be an 8-pole compound-wound machine giving 650 amperes at 500 to 550 volts, or when running as simple shunt, 800 amperes at 445 to 460 volts. The speed will be 300 revolutions per minute in either case; and the dynamo will have a sufficient margin to allow of an overload of 20 per cent. for two hours continuously, or of 50 per cent momentarily.

Messrs. Mather & Platt, Ltd., have also received an order for an extension of the electric power plant, which they lately supplied to a paper factory. This extension consists of a 175-KW. dynamo and 14 continuous-current motors of various sizes from 5-H.P. to 70-H.P., together with switchboard and complete wiring installation.

Coventry.—The E.L. Committee recommends the acceptance of the tender of Messrs. Berry, Skinner & Co., at £83, for sub-station switchgear.

Fulham.—The Board of Guardians have placed the order for fire alarm installation at the Fulham Workhouse and Infirmary with Messrs. Clements, Booker & Co., of Westminster.

Great Western Railway Co.—The contract for all the cranes and runways for the generating station at Park Royal and the five sub-stations, to the specification of Messrs. Kennedy and Jenkin, has been placed with Messrs. Marshall, Fleming & Jack, of Motherwell, N.B.

Hastings.—The T.C. has accepted the tender of the receiver and managers of Ferranti, Ltd., of Hollinwood, for the supply of 20 10-ampere meters at £3 5s. each, 20 25-ampere meters at £3 10s. each; and 10 50-ampere meters at £3 15s. each.

Mexborough.—The following is a list of firms who recently tendered for two 100-KW. direct-driven steam sets. The contract has been placed with Messrs. Mavor & Coulson, with engines by Willans & Robinson (subject to a satisfactory time delivery):—

Mavor & Coulson.	British Thomson-Houston.
Electrical Co.	J. Fowler.
Browett, Lindley & Co.	British Electrical Plant Co.
Witting Bros.	Brush Co.
Bruce Peebles.	General Electric Co.
Harding Churton.	Vicars, Sons & Maxim.
India-Rubber Co.	Electric Construction Co.
Sunderland Forge Co.	Parsons.
Bergmann.	Bumsted & Chandler.
British Westinghouse.	Industrial Engineering Co.
Thos. Parker.	Allen, Sons & Co.
Lancashire Dynamo Co.	Mather & Platt.
Morley Electrical Co.	International Electric Co.
Dewhurst & Co.	Johnson & Phillips.
McClure & Whitfield.	Fullerton.
Hall & Co.	Siemens.
Phœnix Dynamo Co.	Crompton.
Alliance Electrical Co.	Skedding.

Middlesex.—The County Council has received the following tenders for the electric light wiring and fittings of its new asylum at Napsbury:—

Jones & Spence	£3,200
Thos. Potter & Sons	4,496
H. H. J. Pearson, Ltd.	5,022
Wells, Rayner & Co. (accepted)	5,343
Belshaw & Co.	6,000
W. J. Fryer & Co.	6,163
Wenham & Walters, Ltd.	6,549
D. Hulett & Co., Ltd.	7,062
Strode & Co.	7,287
Simmonds Bros.	7,438
Comyn, Ching & Co.	7,700
Allom Bros.	7,770
Wippell Bros. & Row	8,000
F. Suter & Co.	9,374
Hampton & Sons	11,955

Shoreditch.—The B.C. has accepted the tender of the Electric Construction Co., Ltd., for a motor-balancer, at £214.

Stalybridge.—The Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board has accepted the tender of Messrs. Dick, Kerr & Co., Ltd., for the equipment of the overhead wires in the main car-shed.

St. Pancras.—The B.C. received the following tenders for a duplex air compressor:—

Reavell & Co., Ltd. (accepted)	£73 14 6
W. H. Bailey & Co., Ltd.	95 0 0
John McDonald & Son	108 0 0
A. and Z. Daw	151 0 0

South Africa.—The tender of the Hart Accumulator Co., Ltd., has been accepted for a storage battery of 256 central station type cells required by the Town Council of Aliwal North, S. Africa.

Walton and Melton Mowbray.—The D.P. Battery Co. has secured the order for the lighting battery for Walton-on-Thames, consisting of 260 17-plate cells of its Lumford station type in lead-lined wood boxes. The company has also secured the order for the renewal of the battery at Melton Mowbray Electric Lighting Station with a battery of a larger size, consisting of 260 15-plate cells of the same type.

FORTHCOMING EVENTS.

Saturday, June 11th.—At 2 p.m. North of England Institute of Mining and Mechanical Engineers. Meeting at Newcastle-on-Tyne.

NOTES.

The Metal Conduit Correspondence.—In our last issue we closed the correspondence on this subject, but before our intimation to that effect had appeared, Mr. H. W. Rawley, of London, S.W., had put a letter into the post drawing attention to a few facts without touching personalities. He says:—

"Insulated conduits greatly reduce the available diameter for equal exterior measurements. Some correspondents seem to think that it is as easy to draw through lined as unlined tubes. A difference is found in warm weather and warm climates, when both the braiding on the wires and the lining on the tubes becomes somewhat sticky, the risk of a jamb is less in unlined tubes by more than half, since there is only one to stick. . . . The pole-to-pole test in a lined tube is considerably lower to that of an unlined tube on account of the lower grade of insulation advocated. There are, of course, two tests, viz.:—(1) Pole to pole; (2) Pole (either) to earth or tube. When the insulation in a lined tube is taken, in the aggregate we find that we have a poor pole-to-pole test, and the insulation between the wire and the tube is broken up into two doubtful quantities, while with a good grade of wire in an unlined tube the lead, or any section of it, becomes, as it were, self-contained, and is protected completely within its own sheath or covering. The latter must necessarily give at both test 1 and 2, a high figure, not one high and the pole-to-pole test low. The insulating lining cannot be guaranteed continuous even with the special tool Mr. Woodyer mentions. Mr. Woodyer says that the relative cost of insulated tubes and unlined solid drawn steel tubes is about ¾d. per foot; he does not say that the insulated tubes are welded, and not solid drawn. With this so, what a truly funny comparison.

"Why not welded tubes lined and unlined? The figure would then be 2¼d. against 3d., only the unlined tubes, when compared on truly neutral bases, come at about 60 per cent. less than lined, without touching on the great difference in cost of labour."

We do not propose to re-open the correspondence, but as Mr. C. E. Gunner feels somewhat aggrieved at "Tertium Quid's" references to himself in our last issue, we quote the following extracts from a letter received since the correspondence was closed:—

"Your correspondent, 'Tertium Quid,' ignores my opening remark that I had some experience, both of the manufacture and sale of conduits.

"From the way in which he singles me out for criticism, and at the same time backs up a manufacture with which I am not altogether unfamiliar, he must excuse me if I take his preface, to the effect that he is not interested in any particular system, with reservations.

"He certainly does not seem to have a thorough knowledge of the subject on which he poses as an authority, or he would not make such a point of a 'certain *novel* device' for earthing conduits, seeing that a similar device, for the same purpose, was put on the market years ago, by a different company. As to his attempt to belittle my statement *re* brazed tube, I can only say that this class of tube will, in spite of his opinion, still be largely used, and price will be the ruling factor in determining the vendor. He purposely excludes mines, chemical works, &c., from the scope of "the novel device" and ordinary conduits, but offers no alternative system. Might not brazed tube still be employed here? 'Tertium Quid' gives us as his opinion that the selling of conduits does not conduce to mature judgement in questions of its erection. I can see he is not speaking from experience. If he had occupied the same position as I have done for the last three or four years, he would find his knowledge of the subject considerably improved, even to the extent of allowing him to give his opinions on methods of erection. This, however, I did not attempt to do, but simply gave you a summary of the trade requirements as I have found them, which statements 'Tertium Quid' does not attempt to deny, presumably because he cannot. In conclusion, it may explain matters if you state that I am no longer connected with the Simplex Steel Conduit Co."

Junior Institution of Engineers.—The summer meeting is to be held in Germany from August 12th to 27th. The arrangements include:—

August 16th.—Excursion to view the Elberfeld-Barmen suspended electric railway (Langen mono-rail).
August 17th.—At Hanover. Visit the works of Messrs. Körting (makers of large gas engines, &c.); the works of the Westinghouse Brake Co.
August 19th.—At Berlin. Visit the Overhead Railway, and the works of Messrs. Siemens & Halske. Institution summer dinner in the evening.
Saturday, August 20th.—The Technical School, Charlottenburg.

The I.E.E. American Meeting.—We learn that the arrangements for the entertainment of the electrical engineers and their ladies during the visit to America are rapidly taking definite shape. In a letter communicated to us, addressed to the President by Mr. Calvin W. Rice, vice-chairman of the Electrical Congress Reception Committee, who has in hand the organisation of the details of the programme, the latter states that in contrast to the provision made by the American Society of Mechanical Engineers for the reception and entertainment of their sister society during the first week of the current month, preparations on a lavish scale of a much more elaborate nature are in progress for the entertainment of the Institution of Electrical Engineers. The party will be taken charge of throughout their entire trip by the American Institute of Electrical Engineers, and entertainments will be organised in each city visited. Reception Committees are also being formed at every stopping place, whose business it will be to take charge of the ladies of the party. Members are assured that no fears need be entertained regarding hotel accommodation at St. Louis, and rooms may be booked there weeks in advance without incurring any risk of having them on their hands in the event at the last minute of being unable to go to St. Louis, as owing to the great demand for rooms during the time of the Congress, cancellations can easily be effected.

Appointments Vacant.—Charge engineer for Woolwich (£109 4s.); Battery room attendant and wireman for the East Sussex County Asylum (35s.).

Better Left Unsaid.—In the current issue of our contemporary, the *Electrical Magazine*, we note the following singular inset:—"*Erratum.*—Page 504. In the article, 'A Telephone Exchange Storage Battery Explorer,' the word 'Explorer' should read 'Exploder.'"

The "exploder" in question consists of a small water-proof electric lamp, which can be inserted between the plates. The process of "exploding" the battery, however, is not explained, and we must confess our inability to supply the omission. We are, in fact, left in utter darkness on the point, which is not relieved by the excessively naked "Light" portrayed on the front cover of our contemporary.

Royal Institution.—Last Friday evening Prof. Svante Arrhenius, of Copenhagen, lectured before a distinguished company at the Royal Institution, on "Development of the Theory of Electrolytic Dissociation."

At a meeting of the Royal Institution held on Monday afternoon, thanks were returned to Dr. Andrew Carnegie for his donation of £1,200, to enable Prof. Dewar and R. A. Hadfield to prosecute their joint investigation on the physical properties of steel and other alloys at low temperatures.

Electricity Works and Nuisance.—A conference of representatives of electric lighting undertakers (both municipalities and companies) was held at St. Pancras last Saturday, to consider certain clauses in the Electric Lighting Acts, as printed on page 923 of our last issue. The Mayor of St. Pancras, who presided over the proceedings, referred to certain ways in which the Electric Lighting Acts were harsh towards electrical undertakers, and instanced the recent litigation against St. Pancras Borough Council, which compelled the Council to pay "exorbitant compensation" in order to avoid the effects of an injunction. The judge's contention that all vibration was a nuisance, placed electrical undertakers in an anomalous position, and it was suggested that compulsory powers should be applied for, which would enable electricity supply authorities to purchase property affected by vibration. The conference appointed a committee to formulate propositions for action, and report to a meeting to be held later.

Fatality on the Liverpool and Southport Electric Railway.—An inquest was held at Southport on June 3rd, relative to the death of Edward Stanley Jones (13), who was killed on the Lancashire and Yorkshire Railway. The evidence showed that the deceased was trespassing and had climbed over a barbed wire fence on to the electric railway. He stumbled and fell on the live rail, his neck and chest being terribly burned. The coroner (Mr. S. Brighouse) said the railway company were seeking to do a public service by electrifying their line, and had issued warning notices drawing the attention of the public to the danger of coming into contact with the live metals. However sympathetic and compassionate the jury might be they must take into full account all the circumstances. A verdict that deceased was killed by misadventure was returned, both the coroner and jury expressing sympathy with the parents of the boy.

OUR PERSONAL COLUMN.

[*The Editors invite electrical engineers, whether connected with the power station or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.*]

Central Station Engineers.—On April 29th the officials and workmen of the Cape Town Corporation electricity works presented Mr. WALTER FREDERICK LONG, A.M.I.E.E., city electrical engineer, with a pianola, on the occasion of his marriage with Miss Dora Rowlinson, daughter of Mr. Ralf Rowlinson, of

Chorlton-cum-Hardy, near Manchester. The marriage was celebrated the following day at St. George's Cathedral, Cape Town, in the presence of a large number of well-wishers.

Mr. H. EBERT has been appointed chief assistant engineer at the Aldershot E.L. works.

The Devonport Electric Power Committee has recommended the T.C. to increase the salary of Mr. J. W. SPARK, electrical engineer, from £250 to £300 per annum; and that of Mr. W. J. STAMP, assistant electrical engineer, from £130 to £150 per annum.

Mr. HUBERT D. HARRIS has resigned his position on the staff of the Beckenham U.D.C.'s electricity works, in order to take up the appointment of junior electrician-in-charge at the borough of Hornsey's electricity works.

Mr. A. H. SHAW, M.I.E.E., the electrical engineer to the Ilford U.D.C., was married on 1st inst. to Miss H. M. Cassidy, of Ilford. The staff of the electricity department presented a carved oak chiming clock, and the chief officials of the U.D.C. a dessert service.

Mr. OSCAR ST. J. MCKEE has just been appointed resident electrical engineer to Alexander's Electricity Works, Carlow.

Mr. A. R. BACON, chief assistant at the County of London Electric Supply Co.'s station at Wandsworth, has been appointed resident engineer at the company's City Road station.

The name of the new chief engineer at Beckenham electricity works is Mr. J. E. TAPPER, not Sapper (as given in our last issue, and in our Electricity Works Sheet, which went to press early this week, before the correction reached us). The error was not ours, but was due to the chirography of the official from whom the note emanated.

On Wednesday the Southwark B.C. resumed the consideration of a recommendation by the Electrical Committee that the resident engineer (MR. BLAIKIE) be given three months' notice to terminate his appointment. Four weeks ago the matter was discussed, and was adjourned to enable Mr. Blaikie to resign. The Mayor stated that he had received a letter from the engineer, but he (the Mayor) advised that it should not be read. Mr. Chell: Surely it is only justice to the man against whom grave charges are brought, and whose professional future is at stake, that we should hear what he has to say. The Mayor: If the Council place their confidence in me, the letter will not be read. A communication attached to it is of a libellous character. Mr. Edwards, late Chairman of the Committee, said he wrote the communication referred to, and on the previous night gave Mr. Blaikie liberty to use it. It was suggested that Mr. Blaikie's letter be read without Mr. Edwards's communication, but by 35 votes to 11, it was decided to hear neither communication nor letter. Mr. Attenborough protested against the un-English mode of procedure adopted, and asked if Mr. Blaikie had not offered to resign if the imputations made against him were withdrawn? The Mayor replied that in view of the vote taken, he could give no information about the letter. Mr. Edwards opposed the Committee's recommendation. There had been two inquiries into the undertaking. At the first, twelve meetings were held with an average attendance of twelve members, and the recommendations made, contained no charge of maladministration or mismanagement. But the Council, instead of doing what was suggested, referred the matter back, and there was a new inquiry by new men. These, after five meetings with an average attendance of five, brought up the recommendation which was now being discussed. He was sorry that an arrangement had not been come to by which Mr. Blaikie could resign. He would have to go, for an officer at loggerheads with his committee always found his position untenable, but he did not blame Mr. Blaikie for declining to commit professional suicide, for, if he had resigned without conditions, the terms of the Committee's resolution would have been held to be justified. Was it not strange, if the resident engineer was deserving of dismissal, that he should be supported by Mr. Newman, the chairman of the Committee, himself (Mr. Edwards) the ex-chairman, Mr. Hawkins, a practical electrical engineer, and Mr. Anton, also a practical electrical engineer? Mr. Westcott said those supporting the recommendation were accused of lack of electrical knowledge. That might be true, but they had common sense. They did not accuse Mr. Blaikie of maladministration, but of lack of interest in his work and general lack of supervision. Rev. Mr. Pitt said he was convinced that Mr. Blaikie was being made a scapegoat. Mr. Newman said it could not be denied that one of the members of the committee of inquiry went round canvassing for complaints against Mr. Blaikie. Upon a division, the recommendation that the resident engineer be given three months' notice was carried by 35 votes to 11.

Electric Tramway Officials.—Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board, on June 2nd, appointed Mr. H. TAYLOR as chief inspector of tramways.

The Tramways Committee of Bolton T.C. has selected the following out of 224 applicants to appear before the Committee on June 14th concerning the post of assistant engineer of the tramways:—Mr. J. W. ASTLEY, Bolton; Mr. C. BEECH, Stockport; Mr. G. H. BURTON, Birmingham; Mr. D. A. HAMILTON, Lancaster; and Mr. G. MYERSCOUGH and Mr. F. TAYLOR, Manchester.

The Oldham Corporation Tramways Committee, on June 2nd, appointed Mr. Alfred WOOLSTENCROFT, of the Manchester Corporation Tramways, as traffic superintendent.

General.—At the Trocadero Restaurant a dinner was given the other evening to Mr. A. T. DALE, managing director in South Africa of the Cape Town Exhibition. Mr. Dale stated that as the local municipality could not supply the show grounds and buildings with electricity, the Exhibition would have its own generating plant.

Mr. A. E. BENNETT, A.I.E.E. (A. E. Bennett & Co., electrical contractors, 79, High Road, Streatham), who is proprietor of the Streatham Motor Co. and a director of Arc Lamps, Ltd., is retiring from commercial life, and commencing practice as a consulting engineer at the above address.

The German Engineers' Association, which on Monday held its meeting at Frankfort, unanimously conferred the Grashof medal, instituted in honour of the founder of the association, on the HON. C. A. PARSONS, and M. DE LAVAL, of Stockholm, in recognition of their pioneering work in connection with the steam turbine.

The *Australian Mining Standard* says that MR. HENRY DEANE, engineer-in-chief of railway and tramway construction, left Sydney at the end of April for Canada on 12 months' leave, during which he will make inquiries in Canada, the United States, Great Britain, and the Continent on the subject of railway and tramway construction, the use of automobiles as an adjunct to railways, and the application of electricity in working railways and lifts.

Mr. D H. SIMPSON, an assistant at the Corporation electricity works, York, has received an appointment as superintendent engineer under Messrs. Davidson & Co., engineers, of Manchester and Belfast.

Prof. S. P. THOMPSON is the newly-elected president of the Sette of Odd Volumes for this year. "His Oddship" presided at a meeting held last week at the Imperial Restaurant.

We learn, with deep regret, of the death of an old friend in the person of Mr. A. LE NEVE FOSTER, and we believe that our feelings will be shared by a large number of those who are connected with the electrical engineering industry. Mr. Le Neve Foster had been associated with the India-Rubber, Gutta-Percha & Telegraph Works Co., and later with the well-known firm of Davis & Timmins from the years when the electrical industry was a small affair in comparison with what it is now. As managing director of Davis & Timmins, and in other capacities as an electrical engineer, the deceased gentleman was frequently in touch with the electrical profession generally, and his was a disposition which easily made for him a host of friends. His death occurred very suddenly on Tuesday last, June 7th, at Birkenhall Mansions, W., at the age of 61.

The *Indian and Eastern Engineer* says that Mr. MELVILLE WALTON has been sent out by the Bengal-Nagpur Railway Board of Directors for service as assistant electrical engineer in the Khargpur workshops.

From the same exchange we learn that Mr. R. L. D. GOMPERTZ, Director of Telegraphs, having been promoted to Officiating Deputy Director-General of Telegraphs, Mr. F. E. DEMPSTER, C.I.E., Deputy-Director, acts a Director *vice* Mr. Gompertz.

NEW COMPANIES REGISTERED.

Easton Lift Co., Ltd. (81,115).—This company has just been registered, with a capital of £25,000 in £1 shares (5,000 "A" and 5,000 "B" preference, and 15,000 ordinary), to adopt an agreement with W. P. J. Fawcus, and to carry on the business of manufacturers of and dealers in hydraulic, electric, and steam elevators, lifts, steam appliances, and other machinery, mechanical and electrical engineers, tool makers, brass-founders, millwrights, steel converters, smiths, woodworkers, builders, painters, metallurgists, &c. The first subscribers (each with one share) are:—C. B. H. Robson, 34, St. Helens Road, Westcliffe-on-Sea, accountant; H. Gilbertson, "Waverley," Manor Crescent, Sidcup, traveller; S. W. Wilkins, 19, Lanhill Road, W., electrical engineer; W. H. Herod, 47, Daleview Road, Stamford Hill, N., clerk; A. E. Bennett, 16, Waveney Avenue, Peckham Rye, electrical engineer; G. E. Holland, 171, Milton Avenue, East Ham, telephone engineer; and R. C. Poulton, 46, Queen Victoria Street, E.C., solicitor. No initial public issue. The number of directors is not to be less than three nor more than seven; the first are R. A. Smith (nominated by holders of "A" preference shares), G. H. Ide (nominated by holders of "B" preference shares), T. P. Wilson, and S. V. Clirehugh; qualification, 50 shares; remuneration as fixed by the company. Registered office, Broad Sanctuary Chambers, Westminster.

Telephos, Ltd. (81,111).—This company was registered on May 31st, with a capital of £10,000 in 8,000 preference shares of £1 each, and 40,000 ordinary shares of 1s. each, to adopt a certain agreement (the parties to which are not named), to acquire the property mentioned therein, and to carry on the business of suppliers of electricity, electrical and mechanical engineers, manufacturers of and dealers in electrical, magnetic, telegraphic, telephonic and other apparatus and appliances, &c. The first subscribers (each with one share) are:—D. H. Wiseman, 194, Gresham House, E.C., solicitor's manager; J. C. Hailey, 194, Gresham House, E.C., clerk; E. Jacob, Hereford House, South End Green, N.W., clerk; E. Amies, 14, Beatrice Road, Stroud Green, N., gentleman; W. A. Lindsay, 3, Park Lane Mansions, Croydon, gentleman; G. H. Harden, 23, Rood Lane, E.C., tea dealer; and H. S. Rettridge, 70, Morley Road, Chadwell Heath, accountant. No initial public issue. The number of directors is not to be less than two nor more than seven; the subscribers are to appoint the first; qualification, 200 shares; remuneration as fixed by the company.

ELECTRICITY SUPPLY ACCOUNTS.

Burnley Municipal Electricity Supply.

THE returns for the Burnley undertaking show an increased output of 34·5 per cent. for the past year, the greater proportion being due to traction requirements. The combined lighting and traction load factor was 16 per cent., an improvement on the previous year, as are also the total working costs at 1d. (approx.) per unit. The gross profit amounted to £9,439, and after meeting interest and sinking fund charges, there remained a balance of £5,124, as compared with £3,552 last year; £1,500 was allocated to the borough fund, and the remainder to reserve.

The prices charged are:—Private lighting, 4d.; power, 3d. to 1d.; traction, 1½d. per unit. The chief engineer is Mr. R. Birkett.

GENERAL STATEMENT.

For year ending March 31st—	1904.	1903.
Total capital expended	£85,604	£75,147
Number of units sold—		
Private supply	477,699	391,692
Public lighting	9,762	10,552
Traction	1,252,338	891,079
Total number of units sold ...	1,739,799	1,293,323
Equivalent No. of 8-C.P. lamps connected	37,393	31,995
H.P. of motors connected	181	100
Maximum load in KW.	1,247	947
Revenue account—		
Gross revenue	£16,838	£13,456
„ expenditure	£7,399	£5,680
„ profit	£9,439	£7,776
Average inclusive price obtained per unit—		
Private supply	3·93d.	3·95d.
Public lighting	3·00d.	3·00d.
Traction	1·75d.	1·87d.

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31ST, 1904.

Gross revenue	£16,838 = 2·32d.	per unit.
Works and distribution costs (including public lighting)	£5,544 = ·76d.	„
Total working costs	£7,399 = 1·02d.	„

PROFIT STATEMENT.

Interest on loans, &c.	£2,109
Sinking fund...	2,206
Balance carried forward	5,124
Gross profit ...	£9,439

Hull Municipal Electricity Supply.

We give herewith the returns of the Hull Electricity Department for the year ended March 31st last. The output has now reached well over 3 million units, and of this 1,186,486 units were for power. As this large proportion will be increased in the near future by the acquisition of two consumers representing some 1,500,000 units annually, the Hull undertaking will then be in an exceptionally favourable position for economical working. The past year resulted in improved working costs, and the earning of a larger gross profit than previously, and after meeting financial charges, the balance, some £2,800, was allocated to depreciation and reserve purposes.

The prices charged are:—Private lighting, 4½d. flat rate, 5d. and 2d. maximum demand system; power, 2d. to 1d. per unit; public arcs, £22 per annum. The chief engineer is Mr. H. Bell.

GENERAL STATEMENT.

For year ending March 31st—	1904.	1903.
Total capital expended	£282,910	£252,546
Number of units sold—		
Private supply	2,971,428	2,359,177
Public lighting	45,760	26,400
Total number of units sold ...	3,017,188	2,385,577
Equivalent No. of 8-C.P. lamps connected	217,916	192,453
No. and H.P. of motors connected	340 = 2,280 H.P.	234 = 1,959 H.P.
Number of public lamps	32	12
Maximum load in KW.	3,090	2,735
Revenue account—		
Gross revenue	£37,887	£32,270
„ expenditure	£19,660	£16,461
„ profit	£18,227	£15,809
Average inclusive price obtained per unit—		
Private supply	3·25d.	3·25d.
Public lighting	1·56d.	2·40d.

REVENUE ACCOUNT FOR YEAR ENDING MARCH 31ST, 1904.

Gross revenue	£37,887 = 3·10d.	per unit.
Works and distribution costs (including public lighting)	£14,753 = 1·17d.	„
Total working costs	£19,660 = 1·56d.	„

PROFIT STATEMENT.

Interest on loans	£8,427
Sinking fund	6,985
To depreciation on meters	1,176
To reserve fund	1,639
Gross profit	£18,227

CITY NOTES.

A Chance not to be Missed.

Is any one of our readers seeking for a really good investment which shall excel in soundness the security afforded by Consols? It goes against the grain to give away a good tip, but our self-interests are thoroughly subordinated to our regard for the interests of the general public. There is only a modest £3,000 going, and even half of that the vendor is to receive in shares in part satisfaction of the purchase money, so that there are only £1,500 £1 shares open to the public. Really, the matter would be hardly worth mentioning, were it not that the prospectus is a remarkable one in several particulars. The name of the concern is "The Lodge Electric Light and Power Co., Ltd." and it is to take over the "business of Herbert Lodge, trading as the Lodge Electric Lighting Co., of Liverpool, contracting electricians and engineers." Now Mr. Herbert wants £2,000 in shares and cash for the business of which he has "had the active management" "from the commencement," but he does not, so far as we can see, say when that commencement dates from, nor whether any, and if so what, profits have been earned. This £2,000 is arrived at as follows:—Stock-in-trade (what is it?) £500; utensils, chattels, loose fittings, &c., £140; book debts, £267; inventions (*not yet patented*), £494; GOODWILL (!!) £600. The company takes over the business as a going concern (except cash in the bank) as from December, 1903, "with the benefit of and subject to the obligation of all trade contracts current at that date." The vendor is going to pay all of the liabilities up to December 31st, 1903, and when he gets the money which he hopes this issue may provide, the business will be removed from 8A, Lord Street, Liverpool, to much more commodious premises, at 31, Renshaw Street. The directors (Mr. Lodge and one other) are easily satisfied, so anxious are they to proceed to business, for they actually "will not allot *any* shares *unless* 1 *per cent.* of the issue is applied for. One per cent. of £1,500 is £15, and the directors will accept as much more as they can get. They themselves are so essential to the conduct of the company, that their qualification, until the statutory meeting, need be membership only, and thereafter such director must have a stake of not less than £5; and this, notwithstanding the fact that Mr. Lodge has agreed to hold not less than 1,500 ordinary shares during the five years for which he "has agreed" to act as managing director. There is a statement on the prospectus which leads one to suspect that it has been in circulation for some time, for the words "Applications should be sent in not later than May 21st, 1904," have been cancelled in red ink, and another intimation printed at the head says that the list of applications will close on June 17th (Friday next). Electrical men who have received a copy of this prospectus will hardly need to be told how many shares they should take in the concern; but, unfortunately for themselves, the people who go into companies of this sort are not to be found among the regular readers of the technical press.

Diesel Engine Co.

MR. THOMAS SNAPE presided at the meeting of this company held at Cannon Street Hotel on 2nd inst., and in moving the adoption of the report, he said that their progress during the year had been sound. In the first year they sold engines with an aggregate of 324 B.H.P.; in the second year, of 1,870 B.H.P.; and in the third year, of 2,914 B.H.P.; giving a total for the three years of 5,108 B.H.P., of which 3,812 B.H.P. were placed in Great Britain and 1,296 B.H.P. abroad. At the end of 1902 the total number of engines sold by all existing Diesel engine companies reached about 600, with a total of about 20,000 B.H.P., whereas at the end of 1903 the number had grown to about 900, with a total of about 45,000 B.H.P. These figures were taken from the report of the German parent company. He believed the shareholders would agree with him that they proved the Diesel engine to be as yet in its infancy, and now that the engine was well introduced in this country they were justified in expecting a similar growth as regarded volume of business to that which had been experienced elsewhere. The size of the engines three years ago was 60 B.H.P., whereas at the present moment engines of 300, 400, and 500 B.H.P. in single units were being manufactured for the company. An engine of 500 B.H.P. was to be exhibited at the forthcoming Exhibition at Liège, and would be by far the largest oil engine ever made. At the present moment they were treating with a tramway company for engines of 320 B.H.P., with a district council for an engine of 400 B.H.P. for a pumping station, and with a railway company for engines of 600 B.H.P. for the power station of a light railway. The economy of the engine was bound to tell when it became universally known. One of the two manufacturers who were at present supplying the company with engines had enlarged his works and spent a sum of about £20,000 in extensions of buildings and plant, exclusively for the purpose of manufacturing Diesel engines, whilst the other had also considerably enlarged his works.

MR. CARL JEPPE suggested that the meeting should be adjourned for a few days, in order to give the shareholders an opportunity of conferring with the directors, with the view of discussing the future

policy of the company. It was resolved to adjourn the meeting for three days.

The report was unanimously adopted.

It was resolved on the motion of the chairman, "That the remainder of the business, including the election of directors, specified in the notice convening the meeting, do stand over for a period not exceeding six calendar months, and that the meeting be adjourned accordingly." It was also resolved: "That, as requested by the directors, a consulting committee, consisting of shareholders, be elected by the meeting for the purpose of consulting with the board as to the policy and future development of the company, and to assist in framing proposals as to same."

Blackheath and Greenwich District Electric Light Co.

We are informed that the Board of Trade has given its approval of the agreements for the purchase of the Crystal Palace District Electric Supply Co.'s undertaking by the Blackheath and Greenwich District Electric Light Co., and possession of this business is to be given to the company almost immediately. The progress of the Blackheath Co.'s business during the present year to June 1st shows that the number of consumers connected was 1,942, equivalent to 67,451 8-c.p. lamps, and the number awaiting connection is 115, equivalent to 2,822 8-c.p. lamps, together totalling 2,057 consumers, with 70,273 8-c.p. lamps. The number of lamps connected on June 1st, 1904, was 18,094 more than at the same period of last year, and is the largest increase in the history of the company.

The result for the March quarter as compared with last year is approximately as follows.—

	Gross revenue.	Expenditure.	Net revenue.
1904	£6,612	£2,519	£4,093
1903	5,000	2,168	2,832
Increase ..	£1,612	£351	£1,261

West African Telegraph Co.

The directors' report for the year ended December 31st, 1903, to be presented to the meeting to be held at Electra House, E.C., on Thursday, June 16th, reads:—

The revenue for the period under review amounted to £62,514 18s. 4d., from which are deducted £15,578 4s. 4d. for the ordinary expenses, and £9,809 0s. 7d. for expenditure relating to repairs of cables, leaving a balance of £37,127 13s. 5d., to which is added £1,238 5s. 11d. brought from the preceding year, making a total available balance of £38,365 19s. 4d. The sum of £1,459 1s. 3d. has been provided for income-tax, £25,000 transferred to general reserve fund, and an interim dividend of 1 per cent., absorbing £2,310 18s., was paid in January last. The directors recommend the payment of a final dividend of 6s. per share (free of income-tax) making, with the interim distribution, 4 per cent. for the year, the balance of £2,663 6s. 1d. being carried forward to the next account.

Stock Exchange Notices.—The Committee has ordered the undermentioned securities to be quoted in the Official List:—

Edmundson's Electricity Corporation, Ltd.—Further issue of 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 50,001 to 70,000, and a further issue of £31,467 4½ per cent. first morigage debenture stock (redeemable).

Electro-Peat Coal.—We read in the *Westminster Gazette* that some of the proposed "subsidiaries" of the Electro-Peat Coal Co. will be introduced shortly.

Prospectuses.—The subscription list was to close last Monday in an issue of £80,000—4 per cent. prior lien mortgage debentures in the New General Traction Co., Ltd. The price of issue was 97½ per cent. The money was needed for completing certain electric lines in this country and America, and for the general purposes of the company.

It appears that a proof prospectus of the De Forest Wireless Telegraph Syndicate has been issued, and Mr. H. Cuthbert Hall, of Marconi's Wireless Telegraph Co., Ltd., wrote to the *Financial Times* of 7th inst., taking exception to certain comparisons of the Marconi and De Forest systems which appear in the prospectus.

Rhodes Electrical Manufacturing Co.—The directors have declared an interim dividend for the half-year ending May 31st, 1904, at the rate of 6 per cent. per annum (or 7½d. per share) on the ordinary shares of the company.

STOCKS AND SHARES.

Wednesday Evening.

New issues already show faint signs of slackening their demands, although a few substantial amounts have been asked this week from various quarters. The electrical world, as a whole, has held aloof from the prevailing rush to secure more capital at a moment when the public appeared less unwilling to regard such appeals with favour, but the few emissions made recently in connection with such companies have been quickly absorbed. This is strikingly illustrated by the advance in the price of Anglo-Argentine Tramways Ordinary shares. In this case the underwriters were left with 71 per cent. of their applications, yet the public demand during the last few days has been strong enough to raise the quotation 10s. premium over the issue-price of £5 10s. It is singular that those people who would not apply for the shares on the prospectus, are now content to pay what is equivalent to £6 per share.

Telegraphs have decidedly halted on their upward march, and even the Debenture stocks are unchanged. West African Telegraph shares at 6½ have risen 10s., the inanition of the Jungle mining market notwithstanding. Direct United States Cable are ¼ easier at 10½ on the same causes to which we alluded last week as being responsible for dulness in the Anglo-American group, viz., trade depression in the United States, joined with lifelessness in the stock markets and the mal-influence of a coming Election. Cuba Telegraphs, nominally unaltered, are a dull market, sellers being able to get no more than 7 for the shares that are quoted 7 to 8. Commercial Cable Debenture has shed a point. The Eastern group has nothing of interest to mention.

In the House of Commons last Monday Lord Stanley stated that negotiations are still in progress between the Post Office and the National Telephone Co., but this has not saved the Deferred stock from another small drop, whereby the price is lowered to 85½. The Debenture stocks, too, have shrunk a trifle, although only noticeably in the case of the latest issue of Debenture stock, the provisional certificates of which are 1 down at 30. There is 70 per cent. still to be paid on them. Telephone third Preferences are 5 to 5⅛.

This week it is the turn of Telegraph Constructions to advance, and the price is harder at 37½. India-rubber shares maintain their earlier rise, and the Debenture stock at 101½ is up a point. British Insulated Ordinary have shared in the movement by adding ¼ at 5⅞, but Crompton Debentures have shaded off to 96½, a 1 per cent. fall. Edison & Swan are steady; the scheme, although passed, does not receive the full approval of some, who would like to have seen a much more drastic re-organisation of the company's finances. British Westinghouse Preference are again duller at 3¼. Shares have changed hands at 3⅛ and 3⅜ just lately. The Debenture stock stays about 88½, and British Thomson-Houston Debenture is 102. Babcock and Wilcox Ordinary are firm at 2⅞, and the Preference at 30s. These three last-named companies are all doing important work on the new electric power station at Chelsea that is to supply power for the Yerkes group of underground railways. The *Westminster Gazette*, in the course of an informing article on the new erection, says that the Metropolitan District (*sic*) Railway has a power station being built at Neasden!

Districts are dull at 38¼, lacking clique and public support, but Metropolitan Ordinary has been actively bought, the price rising one day to 98, from which it has receded again to 97½. There are more whispers that the buying may be for "control" purposes. City and South Londons also hardened to 52 middle, but are back to 51, their last week's price. After their erratic movements, the Central London trio marked time. An impression prevails that, though the competition on the electrified District may temporarily jeopardise the dividend on the Tube's Deferred stock, the Ordinary and Preferred may be considered as fairly certain to receive their regular 4 per cent. Waterloo and City has not recovered its slight decline.

In the Traction list, Anglo-Argentines are commanding a good deal of interest, and reference has been made in the opening paragraph to the improvement in the price of the Ordinary shares. The Preference, however, are a little lower at 5½, and the Debenture stock difficult to buy at anything like its medium quotation of 133½. City of Buenos Ayres shares are being done at 9½, and the company's Debenture stands about the same level as that of the Anglo-Argentine: both are 6 per cent. stocks. Metropolitan Electric Tramways Preference changed hands at 18s. 1½d. this week, but there is nothing doing in the Ordinary, which are 4s. British Electric Tractions continue steady at their improved values, and there is a good deal doing in the Preference shares. The Second Debenture stock has rather come on offer at 99, or possibly less, but the First Debenture makes a point rise at 117½. British Columbia Preferred Ordinary has hardened to 99½, and Bath Electric Preferred Ordinary at ⅝, are 1/16 up. Buenos Ayres and Belgrano Second Debenture is 2 better at 89½.

Business in Electrical Supply descriptions is decidedly better, and what shares come to market are readily absorbed. Blackheath and Greenwich Preference, at 1½, have risen ⅛; these are the shares of which we ventured to suggest a purchase a few weeks ago, when the price was nearer 20s. Chelseas are ¼ off, at 6¼, and so are Bromptons, at 10⅜, but Charing Cross gained a similar fraction, at 7⅜. One or two Debenture stocks have slightly advanced, and a narrowing of the quotation in Edmundson's Ordinary may be noted with satisfaction, not to say with a wish that the reform might be extended to the whole of the list.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1901.	1902.	1903.	Closing Quotations June 1st.	Closing Quotations June 8th.	Business done week ended June 8th, 1904. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	99 —103	99 —103	..	..
25,000	Amason Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700‡	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	.. — ..	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	61s.	60/6	61s.	48 — 51	48 — 51	48	..
3,105,580	Do. do. do. 5 % Pref.	Stock	6 %	6 %	6 %	92 — 94	92 — 94	93	92½
3,105,580	Do. do. do. Deferred	Stock	2s.	1/-	2s.	7 — 7½	7 — 7½	7 1/16	7
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	6 %	..	4½ — 5½	4½ — 5½	..	..
18,333,300$	Commercial Cable	$100	8 %	8 %	..	175 —185	175 —185	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	94 — 96	93 — 95	95½	94
16,000	Cuba Telegraph	10	4 %	6½%	5 %	7 — 8	7 — 8	7⅞	7
6,000	Do. 10 % Pref.	10	..	..	..	15 — 16	15 — 16	..	..
12,981	Direct Spanish Telegraph	..	..	..	..	.. — ..	.. — ..	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
80,000	Do. do. 4½ % Debs.	50	..	..	..	100 —103%	100—103	..	..
69,710‡	Direct United States Cable	20	3½%	3½%	..	10½ — 10¾	10 — 10⅛	10⅛	10⅛
85,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	100 —103	100 —103	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	..	126 —131	126 —131	130½	127
1,955,565	Do. 8½ % Pref. Stock	100	..	..	..	87 — 90	87 — 90	88	..
1,534,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	106½	106
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11⅜ — 12½	11⅜ — 12½	12⅜	11⅞
890,000‡	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	105½	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000‡	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	99 —102	99 —102	..	..
180,227	Globe Telegraph and Trust	10	5½%	£3 16 7*	5½%	8⅞ — 9⅛ xd	8⅞ — 9⅛	9⅛	8⅛
180,042	Do. do. 6 % Pref.	10	..	..	..	13 — 13½	13 — 13½	13 1/16	13⅛
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	12½%	15 %	25 — 26	25 — 26	25⅜	..
58,700	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,300, Red.	100	..	..	..	100 —103	100 —103	..	..
17,000	Indo-European Telegraph	25	10 %	10%	10 %	42 — 45	42 — 45	45	44½
1,988,338	National Telephone, Pref. Stock	100	5 %	6 %	6 %	104 —106	104 —106	105½	104
1,966,667	Do. do. Def. Stock	100	..	4½%	5 %	85 — 88	84 — 87	86¼	85
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11 — 13	11 — 13	..	..
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5½	5 — 5½	5 1/16	5 1/16
000,000‡	Do. do. 5% Deb. Stock Red.	Stock	3½%	3½%	3½%	98 — 100	98 — 100	99½	99½
699,593	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	103 —105	103 —105	103	..
1,000,000	Do. do. Prov. Certs., 70 % to be paid	..	..	..	..	30 — 32	29 — 31	30⅜	30⅛
179,313	Oriental Telephone and Elec. Nos. 1 to 171,50s, fully paid	1	6 %	6 %	6½%	1 1/16 — 1 1/16	1 1/16 — 1 1/16	..	..
50,000	Do. do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1 1/16	1 1/16	..
100,000‡	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,899	Reuter's	8	5 %	..	..	6¾ — 7⅛	6¾ — 7⅛	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	117 —122	117 —122	..	..
58,000	United River Plate Telephone	5	7 %	7 %	..	5½ — 6	5½ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4½ — 5½	4½ — 5½	..	..
179,947‡	Do. do. 5 % Debs.	Stock	..	..	..	103 —106	103 —106	..	..
15,600	West African Telegraph, Shares	10	..	2 %	4 %	5⅛ — 6⅛	6 — 7	..	..
150,000‡	West Coast of America, 4% Debs., 1 to 1,500 guar. by Bras. Sub. Tel.	100	..	..	..	97 —100	97 — 100	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980	10	7 %	7 %	7 %	12⅜ — 13⅛	12⅜ — 13⅛	13⅛	12⅜
75,000‡	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	101 —104	101 —104	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	100 —103	100 —103	103	102
86,291	West India and Panama Telegraph	10	..	..	..	⅜ — ½	⅜ — ½	..	..
84,552	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	5½ — 6⅛ xd	5½ — 6⅛	..	..
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	5 — 6	5 — 6	..	..
60,000‡	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	100 —103	100 —103	102½	102

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	5 — 6	5 — 6	..	..
300,000‡	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	..	..	..	90 — 95	90 — 95	..	..
100,000	British Electric Traction	10	9 %	8 %	..	9⅜ — 10⅛	9⅜ — 10⅛	10⅛	9⅞
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	10⅛ — 11	10⅛ — 11	10⅛	10 1/16
600,000‡	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	115 —118	116 —119	117½	116½
100,000	British Insulated and Helsby Cables	5	10 %	10 %	8 %	5½ — 5⅝	5⅝ — 6	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5⅛ — 5⅜	5⅛ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —105	102 —105	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	..	..	1/16 — 1/8	1/16 — 1/8	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	..	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	Nil	Nil	Nil	½ — 1	½ — 1	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	3 %	6 %	6 %	1 — 1½	1 — 1½	..	..
125,000‡	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	96 — 99	96 — 99	..	..
125,000‡	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	73 — 78	73 — 78	..	..
35,000	Callender's Cable Construction shares	5	20 %	15 %	12½%	10 — 11	10 — 11	10⅛	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5½ — 5⅝	5½ — 5⅝	5½	..
90,000‡	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	104 —108	104 —108	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	92 — 95	92 — 95	94½	93½
494,093	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	101 —104	101 —104	103	102
494,993	Do. do. Def. do.	Stock	4 %	4 %	4 %	83 — 86	83 — 86	84	..
1,330,000	City and South London Railway	Stock	2 %	3½%	2½%	50 — 52	50 — 52	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	7½%	5 %	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
100,000‡	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	96 — 99	95 — 98	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £3 paid, 1 to 99,261	5	Nil	Nil	..	⅛ — ¼	⅛ — ¼	..	..
17,189	Do. do. "A" shares, 01—017,189	5	Nil	Nil	..	⅛ — ⅛	⅛ — ⅛	..	..
44,023‡	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	..	..
100,000‡	Do. do. 5 % 2n Deb. Stock Prov. Certs. all pd.	100	..	..	..	74 — 79	74 — 79	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	..	1⅜ — 1⅝	1⅜ — 1⅝	..	..
31,890	Do. do. 7 % Cum. Pref., 1 to 31,890	2	..	..	..	2⅛ — 2⅜	2⅛ — 2⅜	..	..
82,500‡	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	..	9⅛ — 9⅜	9⅛ — 9⅜	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	98 — 98	93 — 98	..	..
200,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	15 %	11⅛ — 12⅛	11⅛ — 12⅛	11⅞	11⅛
200,000	Do. do. 4½ % Pref.	5	..	..	..	5 — 5⅛	5 — 5⅛	..	..
45,900	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	107 —111	107 —111	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	..	19 — 20	19 — 20	19½	..
800,000‡	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	99 —102	100 —103	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	1½%	..	3⅞ — 4	3⅞ — 4	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10 — 10½	10 — 10½	..	..
87,350	Telegraph Construction and Maintenance	12	20 %	20 %	20 %	35 — 38	36 — 39	38	37
150,000‡	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	101 —104	102½	..
540,000‡	Waterloo & City Railway, Ord. Stock	100	3 %	3½%	3½%	89 — 92	89 — 92	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 3 per cent. (April 21st, 1904)

SHARE LIST OF ELECTRICAL COMPANIES (continued).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years 1901.	1902.	1903.	Closing Quotations June 1st.	Closing Quotations June 8th.	Business done week ended June 8th, 1904. Highest.	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord...	‡ 1	..	..	..	5/8 — 7/8	5/8 — 7/8	..	..
50,000	Do. 7 % Pref.	1	..	..	..	1 — 1⅛	1⅛ — 1⅛	1 7/8	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs. ..	100	..	..	..	120 —125	120 —125	123½	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000 ..	5	8 %	8 %	10 %	10⅜— 11¼	10¼— 11	10½	..
20,000	Do. do. 7 % Cum. Pref. ..	5	..	..	..	10¼— 10⅜	10¼— 10⅜	..	..
250,000	Central Electric Supply 4 % Guar. Deb. Stock	100	..	..	..	105 —108 xd	105 —108	..	..
50,000	Charing Cross and Strand Electricity Supply	5	10 %	10 %	8 %	7⅛— 7⅜	7⅛— 8	7⅞	7⅜
70,000	Do. do. do. 4½% Cum. Pref. ..	5	..	..	..	5⅛— 5⅜	5⅛— 5⅜	5 7/16	5⅜
40,000	Do. do. "City Undertaking" 4½% Cum. Pref. ..	5	..	..	..	4½— 5	4½— 5	..	..
40,000	Do. do. 1903	5	..	..	..	4½— 5	4½— 5	4 15/16	..
250,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	103 —105	104 —106	105	101¼
44,496	*Chelsea Electricity Supply, Ord.	5	4 %	4½%	5½%	6½— 6⅝	6 — 6⅛	6⅛	6⅛
150,000‡	Do. do. % Deb. Stock Red.	Stock	..	..	..	107 —110	107 —110	..	..
70,596	City of London Electric Lighting, Ord. 40,001—110,595 ..	10	5 %	5 %	5 %	10¾— 11¼	10¾— 11¼	11⅛	11
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	..	..	..	13 — 14	13 — 14	..	..
400,000‡	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	..	..	..	..	121 —126	121 —126	..	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	100	..	..	..	101 —104	101 —104	102½	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000..	10	4 %	4 %	4 %	7⅛— 8⅛	7⅛— 8⅛	7⅛	7⅛
20,000	Do. do. do. 6 % Pref., 40,001—60,000..	10	..	..	..	11 — 12	11 — 12	11⅛	..
400,000‡	Do. do. 4½% Deb. Stock	..	..	..	..	106 —109	106 —109	108	..
250,000	Do. do. 4½% 2nd Deb. Stock	Stock	..	..	..	99 —102	99 —102	100⅛	..
50,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	..	5½— 6	5⅝— 5¼	5 13/16	5 27/32
30,000	Do. do. 6 % Cum. Pref.	..	..	..	..	5⅝— 5⅞	5⅝— 5⅞	5 13/16	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock ..	100	..	..	..	105 —108	105 —108	107½	106⅝
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	10 %	12½%	11½— 12¾	11½— 12¾	..	..
90,000	Do. do. do. 4 % Debenture Stock ..	Stock	..	..	..	103 —105	102 —105	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	3	..	..	..	1½— 1¾	1½— 1¾	1⅜	..
49,840	Do. do. do. 6 % Pref.	5	..	..	..	4½— 5	4½— 5	..	..
250,000‡	Do. do. do. 4 % 1st Mort. Deb. Stock Red	Stock	..	..	..	95 — 98	95 — 98	97	..
100,000	Metropolitan Electric Supply, 1 to 100,000	10	6½%	7½%	8⅝%	19½— 20½	19½— 20½	19⅝	19⅜
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid ..	5	..	..	..	5⅝— 5⅞	5⅝— 5⅞	5 7/16	5 5/16
220,000‡	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	109 —113	109 —113	..	..
250,000‡	Do. do. 3½% Mort. Deb. Stock Red	Stock	..	..	..	97 —100	97 —100	99	..
10,853	Notting Hill Electric Lighting	10	6 %	6 %	6 %	12½— 13½	12½— 13½	12⅝	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14 — 15	14 — 15	14⅛	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	..	..	..	8 — 9	8 — 9	..	..
150,000‡	Do. do. do. 3½% Deb. Stock Red ..	100	..	..	..	97 —100	97 —100	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	..	2½%	4 %	3 — 3½	3 — 3½	4	3 1/16
50,000	Do. do. do. 4 % Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
65,000	South London Electricity Supply, Ord.	5	..	1½%	3 %	3⅜— 4⅛	3⅜— 4⅛	..	..
80,000	Urban Electric Supply, Ord.	5	..	..	..	4⅜— 4⅝	4⅜— 4⅝	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜— 4⅝	4⅜— 4⅝	..	..
110,000	Westminster Electric Supply, Ord.	5	10½%	12 %	13½%	12¾— 13½	12¾— 13½	13 5/16	12 13/16
28,141	Do. do. 5 % Cum. Pref.	5	..	..	..	6¼— 6⅝	6¼— 6⅝	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, June 8th.

	CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a	Acid, Hydrochloric	per cwt.	5/-	..
a	" Nitric	per cwt.	22/-	..
a	" Oxalic	per cwt.	32/-	..
a	" Sulphuric	per cwt.	5/6	..
a	Ammoniac, Sal	per cwt.	42/-	..
a	Ammonia, Muriate (crystal) ..	per ton	£33 10	..
a	" "	per ton	£30	..
a	Bleaching powder	per ton	£4 10	..
a	Bisulphide of Carbon	per ton	£15	..
a	Borax	per ton	£13	..
a	Benzole (90 %)	per gal.	7/-	..
a	" (50/90 %)	per gal.	5/6	..
a	Copper Sulphate	per ton	£21 10	..
a	Lead, Nitrate	per ton	£24	..
a	" White Sugar	per ton	£31	..
a	" Peroxide	per ton	£27 10	..
a	Methylated Spirit	per gal.	2/6	..
a	Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a	Potash, Bichromate, in casks ..	per lb.	3d.	..
a	" Caustic (75/80%).. ..	per ton	£24	..
a	" Bisulphate	per ton	£35	..
a	Shellac	per cwt.	220/-	5/- inc.
a	Sulphate of Magnesia	per ton	£4 10	..
a	Sulphur, Sublimed Flowers ..	per ton	£6 10	..
a	Recovered	per ton	£5 10	..
a	" Lump	per ton	£5	..
a	Soda, Caustic (white 70 %) ..	per ton	£10 15	..
a	Crystals	per ton	£8	..
a	Bichromate, casks.. ..	per lb.	2½d.	..
	METALS, &c.			
b	Aluminium Ingots, in ton lots ..	per ton	£180	..
b	" Wire, in ton lots ..	per ton	£168	..
b	" Sheet, in ton lots ..	per ton	£166	..
p	Babbitt's metal ingots	per ton	£43 to £130	..
c	Brass (rolled metal 2" to 12") basis	per lb.	6½d.	..
c	" Tube (brazed)	per lb.	8¼d.	..
c	" " (solid drawn).. ..	per lb.	7½d.	..
c	" Wire, basis..	per lb.	6¾d.	..
c	Copper Tubes (brazed)	per lb.	9½d.	..
c	" " (solid drawn) ..	per lb.	9¼d.	..
g	Copper Bars (best selected ..	per ton	£72	..

	METALS, &c. (continued).		Latest Price.	Week's Inc. or Dec.
g	Copper Sheet	per ton	£72	..
g	" Rod	per ton	£72	..
e	" (Electrolytic) Bars ..	per ton	£64	..
e	" Sheets ..	per ton	£80	..
e	" Rod ..	per ton	£74	..
e	" H.C. Wire	per lb.	8d.	..
f	Ebonite Rod	per lb.	8/8	..
f	" Sheet	per lb.	8/-	..
n	German Silver Wire	per lb.	1/6	..
h	Gutta-percha fine	per lb.	8/-	..
h	India-rubber, Para fine	per lb.	4/9 to 4/10	dec.
i	Iron, Charcoal Sheets	per ton	£18	..
i	" Pig (Cleveland warrants)	per ton	42/11	7d. dec.
i	" Forgings, according to size	per ton	From £11	..
i	" Scrap, heavy	per ton	47/6 to 50/-	..
i	" Wire, galvanised No. 8 ..	per ton	£9 15	..
g	Lead, English Ingot	per ton	£12	5/- inc.
g	" " Sheet	per ton	£18	..
m	Manganin Wire No. 28	per lb.	8/-	..
g	Mercury	per bot.	£9	2/6 dec.
d	Mica (in original cases) small ..	per lb.	6d. to 1/	..
d	" " " medium	per lb.	2/6 to 4/-	..
d	" " " large ..	per lb.	4/6 to 8/6	..
p	Phosphor Bronze, plain castings	per lb.	1/- to 1/9½	..
p	" rolled bars & rods	per lb.	1/- to 1/8	..
p	" " strip & sheet	per lb.	From 1/1	..
o	Platinum	per oz.	£4	..
e	Silicium Bronze Wire	per lb.	9d. to 11d.	..
i	Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i	" " in bars	per ton	£15 to £40	..
g	Tin, Block	per ton	£123 to £124	£1 dec.
g	" Foil	per lb.	1/6	..
m	" Wire, Nos. 1 to 16	per lb.	1/6½	½d. dec.
p	White Anti-friction Metals— "White Ant" brand ..	per ton	£42 to £62	..
j	Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j	" 6 lea. Flax	per lb.	5½d.	..
j	" 8 ply 10 lbs. Russian ..	per lb.	4½d.	..
j	" 10 lbs. Russian, single ..	per lb.	4½d.	..
j	" 180 lbs. Jute rove ..	per ton	£11	..
k	Zinc, Sh's (Vieille Montagne bnd.)	per ton	£25 5	..

Quotations supplied by Messrs.:—a G. Boor & Co.; b The British Aluminium Co., Ltd.; c Thos. Bolton & Sons., Ltd.; d F. Wiggins & Sons.; e Frederick Smith & Co.; f India-Rubber, G.P. and Teleg. Works Co., Ltd.; g James & Shakspeare; h Edward Till & Co.; i Bolling & Lowe; j Walter H. Hindley and Co., Ltd.; k Morris Ashby, Ltd.; m W. T. Glover & Co., Ltd.; n P. Ormiston & Sons; o Johnson, Matthey & Co., Ltd.; p The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Aberdeen	June 4	1,585	+289	1	—	—	10	—
	Birmingham ..	" 4	5,582	—628	23	121,650	+ 6,682	3¼	—
	Bournemouth ..	" 1	1,026	—382	9	10,064	—	10½	—
	Blackburn	" 4	988	—320	10	9,381	+ 432	13½	—
	Blackpool	" 2	1,667	— 54	9	7,943	+ 1,787	8½	—
	" —Fleetw'd	" 4	775	—1287	23	7,631	— 367	7½	—
	" —Lytham	" 2	782	+217	31	6,920	+ 5,826	7½	—
	Bolton	" 5	2,223	—247	10	18,229	— 15	25	—
	Bradford	May 28	5,947	+2094	8	37,729	+ 7,719	46	—
	Brighton	June 5	890	—354	—	8,648	—	7½	—
	Bristol	" 3	5,172	—2826	—	—	—	28	—
	Devonport ..	May 27	600	+142	21	10,161	+ 1,552	5	—
	Dudley—Sto'rb'ge	" 27	1,490	+661	21	16,981	+ 1,862	18½	—
	Gateshead ..	" 27	1,039	+145	21	18,438	+ 1,091	10½	+ ½
	Gr'n'k—Pt. Glsgw	" 27	706	— 19	21	10,527	+ 652	7½	—
	Hartlepool ..	" 27	442	+167	21	5,564	+ 714	6½	+2
	Oldham—Ashton	" 27	640	— 5	21	10.930	— 537	8	—
	Potteries	" 27	1,967	+316	21	35,284	+ 2,962	26½	—
	Southport	" 27	559	+246	21	5,937	+ 685	5½	—
	South Staffs. ..	" 27	1,202	+239	21	16,453	+ 96	21½	—½
	Swansea	" 27	942	+ 424	21	10,569	+ 896	5½	—
	Wolverhampton..	" 27	732	+336	21	7,774	+ 92	10½	+8
	Yorks. Wool Dist.	" 27	806	+425	21	11,893	+ 5,200	6	—
	(Miscellaneous ..	" 27	4,346	—	21	51,048	—	—	—
	Burnley	June 4	1,093	+123	—	—	—	10½	+3½
	Burton-on-Trent ..	" 5	344	—	9	4,289	—	8½	—
	Cardiff	" 4	2,166	—568	9	19,031	+ 580	1	—
	Chatham & District	" 2	588	—176	22	11,959	+ 1,782	8·53	—
	Cork	" 2	539	—154	22	9.248	— 574	9	—

* Compared with the corresponding period of 1903.

	Locality.	Week ending	Receipts for the week. £	£*	No. wks.	Total to date. £	£*	Miles open.	*
	Dover	June 4	201	— 76	23	4,127	— 283	3	—
	Dublin	" 3	5,652	— 405	23	101,930	+ 1,953	47	+ ½
	East Ham	" 4	739	—257	9	7,180	+ 655	5	+ ½
	Glasgow	" 4	16,040	+ 665	1	—	—	70	+5
	Halifax (2 weeks) ..	" 1	3,593	— 342	9	18,191	+ 499	33	+2
	Huddersfield ..	May 28	1,719	+ 457	8	—	—	28	—
	Hull	June 4	2,165	+ 71	9	19,776	+ 1,850	18	+2½
	Ilkeston	" 1	144	—200	1	—	—	4	—
	Ipswich	" 4	472	—	9	4,416	—	10½	—
	Isle of Thanet ..	" 4	533	—478	22	7,865	— 422	10½	—
	Leeds	" 4	5,850	—1888	—	57,794	+ 2,860	81½	+2
	Liverpool	May 28	11,342	+ 481	22	215,550	+ 4,953	109	—
	London C. C. ..	" 28	13,260	+ 2181	8	93,463	+16,063	87½	—½
	Manchester	June 1	12.845	—3178	9	109,617	+ 681	131½	—
	Newcastle	" 4	3,704	+ 867	—	—	—	17	—
	Portsmouth	" 4	1,904	—579	—	17,717	+ 1,402	14½	—
	Salford	" 6	4,118	— 1490	—	39,506	+ 3,965	30	—
	Sheffield	" 5	4,662	—986	10	47,796	+ 1,048	33	+5½
	Southampton	" 2	992	—374	—	—	—	9	—
	Southend-on-Sea ..	" 1	309	+ 178	9	2.723	+ 169	6½	—
	Sunderland	" 5	1,830	— 471	9	11,755	+ 251	20	+1
	Tyneside	" 2	868	+ 266	22	6,902	+ 770	8·9	+ ·1
	West Ham	" 2	1,055	—	14	8,748	—	8	—
	Wolverhampton ..	" 1	588	+ 16	—	—	—	7·38	—
	Cen. London Rly. ..	" 4	6,726	— 641	23	158,406	— 2,684	6	—
	City & S. Lon. Rly.	" 5	2,859	+ 210	23	68,370	— 2,126	6½	—
	Dublin—Lucan Rly.	" 5	162	— 19	23	2,461	+ 192	6½	—
	L'pool Overh'd Rly.	" 5	1,597	—409	23	36 811	— 96	9½	—
	Metrop. Railway ..	" 4	1,401	— 79	23	8 782	— 6,616	4	—

INSTITUTION OF ELECTRICAL ENGINEERS.

POWER STATION DESIGN.

By C. H. Merz, Member, and Wm. McLellan, Associate Member.

(Paper read in London, April 28th, 1904.)

(Concluded from page 932.)

The desirability of locating the machine and switch panels directly opposite their respective generators or cables has been previously referred to, but this arrangement necessarily involves a switchboard extending the whole length of the station. It is evident that the switches on such a board must be operated from some central point in the station, *i.e.*, the switches must be controlled from a distance. There are three ways of effecting this:—

1. Electrically, as has lately been successfully adopted and developed by the General Electric Co., of America.

2. Mechanically, as railway points are now worked from a signal cabin. In this case automatic devices must be electrically tripped.

3. Pneumatically, simply substituting compressed air as the operating agent.

There is very little difference between the three methods so far as adaptability is concerned—for reliability we prefer either (1) or (2). In each case the operating platform can be kept small so that all the gear is under the eye of the operator. In fact, its length is really limited by the room taken up by switchboard instruments more than by any levers, switches, or valves necessary for the mechanical, electrical, or pneumatic operation. Generally speaking, the longer the board the more desirable does electrical operation* throughout, appear to be.

Under oil-switches we have referred to the necessity for opening all circuits by the switch, rather than by fuses. This means that it is almost essential that automatic overload devices should be installed, so as to operate the switches on each outgoing feeder. When automatic switches first replaced fuses, such overload devices were manufactured on the same lines as an ordinary direct-current traction circuit-breaker. This design, while entirely satisfactory in the case of an ordinary direct-current traction supply, where a momentary stoppage is of relatively small importance, is quite out of the question in the case of a power system from which not only lighting and power are supplied, but on which revolving synchronous sub-station machinery may be running. The shut down of a feeder means the shut down of a sub-station, and this is a serious matter. It was found that such circuit-breakers were apt to operate with instantaneous overloads which would have cleared themselves had pressure been maintained. In order to avoid this trouble, clockwork time-limit devices were tried with equally unsatisfactory results, as when the clockwork devices were set so as to keep the switch "in" on small short circuits such as were likely to clear themselves, they refused to open sufficiently rapidly on bad shorts, so upsetting the whole system.

It was suggested, therefore, by several engineers and manufacturers independently that what was required was an automatic device which imitated the action of a fuse; that is to say, an automatic adjustable circuit-breaker having a time lag inversely proportional to the magnitude of the overload. Various manufacturers have endeavoured to meet this condition in different ways,† but though great improvements have been effected it cannot yet be said that any protective devices have been perfected, which can be depended upon under all conditions on a complicated system to cut out a faulty feeder or machine, without affecting the working of other apparatus. Outgoing connections from the bus-bars may be more or less satisfactorily protected as above, but if similar overload devices are used in the machine circuits, it is practically impossible by any graduation to ensure that the feeder and not the machine circuit will open in the case of an outside short circuit, while it is equally difficult to so discriminate that the faulty and not a sound machine is cut out in the case of a short circuit occurring on one of the generators. Endeavour has therefore been made to fit relays which would only operate with reverse current‡ having a time limit inversely proportional to this reverse current, but which would not respond to any overloads or shorts so long as a positive direction of current was maintained. This latter arrangement would at first sight appear a satisfactory solution of the problem, but in practice it is very far from being so. All such reverse devices so far put to commercial use depend for their action on a potential coil. It is just when the short-circuit is most severe that these devices are wanted, and the difficulty is that with a severe enough short circuit the potential may drop considerably before the faulty machine is cut out, with the result that the apparatus fails to operate.

Another objection to the present type of relay (both overload and reverse) is that in the case of a heavy fault, when the whole of the network may be affected, the cut-outs in other sub-stations than the one at the end of the faulty feeder operate and thus shut down the supply; this is especially liable to happen on polyphase systems when the fault develops between two phases only or between one phase and earth, in this case all motors and transformers on the system immediately tend to pump current into the fault. The authors are of opinion that at the present time automatic protective devices require more attention than any other subject in connection with reliability of supply.

Hitherto we have dealt with the main board and high tension apparatus only, the low tension switchgear and connections may, however, represent a large part of the total expenditure on switchgear, as they control all the auxiliary apparatus, the exciting circuits, and all the lighting for the power station and adjoining yards and shops. The same points which have been referred to in detail when dealing with the main board and connections, apply to the low tension apparatus and cables, though, of course, in lesser degree. It is certainly important that all low tension connections, should be kept entirely separate from high tension connections or cables, in order that no fault of the former may affect the latter. The authors have a strong preference for wiring on insulators as against wiring in pipes for all small wires and for all lighting work. It is cheaper, it gives less trouble in practice, and any fault is more readily seen. This system, however, can only be carried out in cases where proper sub-division is resorted to, and where the circuits are not crowded together.

6.—Measuring Apparatus and Records.

In general, while very complete station records are kept of the data directly affecting the electrical side of the generating plant, scant attention is paid to boiler house records, so far as the factors governing the economy of the boilers are concerned. This would appear to be a mistake, as it will almost invariably be found that the boiler house equipment will give a greater return for any trouble taken with it, than will either the engine room or the electrical apparatus. The efficiency of the electrical and engine room apparatus are comparatively easily ascertained by fairly accurate instruments. On the other hand, tests on the boiler house apparatus are frequently of so rough and ready a description as to at once arouse doubts as to their accuracy, and, as a consequence, they are taken less and less frequently. It is, however, possible, and it is certainly desirable, to get data from the boiler house plant of very approximate accuracy. Complete records should be kept showing the performance of the various component pieces of apparatus throughout the whole process of generating electricity from coal, and an assistant with some chemical knowledge should be made responsible for the boiler house economy and for keeping accurate data in connection therewith.

We will briefly refer to the apparatus necessary for keeping a check on the economy of the station:—

Coal-Weighing Apparatus.—The coal-weighing apparatus should consist of:—

(*a*) A main coal truck weighbridge for checking the railway company and the colliery.

(*b*) An apparatus for weighing the coal fed to each boiler from the overhead bunkers (if these are erected).

The latter may be used either continuously or for special tests. The weighbridge should certainly be used continuously.

Coal Analysis.—It is as important to check accurately the calorific value and the percentage of ash contained in the coal purchased as it is to check its weight, and an analysis should, therefore, be taken from weekly samples of the coal used.

Apparatus for Analysing Flue Gases.—Records of the flue gas composition are also of importance. There are several instruments in the market for taking continuous records, but none of them seem likely to displace the Orsett apparatus.

The Measurement of Temperature.—Ready means should also be provided for obtaining the following thermometric records:—Temperature of superheat, temperature of air-pump discharge, temperature of feed-water before and after economiser, temperature of flue gases before and after economiser and at various positions along the flue.

Water-Measuring Apparatus.—Continuous records should be kept of the whole of the feed water, the make-up water, and the water purchased from the water company. Permanent arrangements should further be made for measuring the air-pump discharge of any one unit. This is comparatively inexpensive, yet it is to be found in very few stations. The simplest way to obtain this information is to have a two-way valve on the air-pump discharge, one way of which is connected to a special pipe leading to duplicate measuring tanks so that the discharge from any unit may be accurately ascertained for any period of test.

Pressure Gauges.—The steam and vacuum gauges call for no remark. Draught gauges are of more importance in stations fitted with mechanical draught than they are in stations fitted with natural draught, and it is only by frequent observation that the best draught, the best thickness of fire, and the best speed of stoker travel can be maintained.

Output Meters.—The wattmeters may either be placed on the main bus-bars between the feeder panels, on each individual machine, or on each of the outgoing feeders. These meters necessarily complicate the switchgear materially, but it is absolutely necessary to provide them. In order that it may be convenient, without alteration to the connections, to test the output of a main generating unit at any time, it would seem to be correct to place them in the generator leads. A further advantage of this is, that in a modern station it involves fewer meters than if they be placed in the feeder cables. Power factor indicators are only of importance where the power factor is under control, as in the case of a station having a combined synchronous and induction motor load,

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* It is desirable that the operating leads should be kept entirely separate from the instrument leads, and further that the leads for each machine should be kept separate and run in accessible positions.

† See "Protective Devices for High-Tension Electric Systems," by W. B. Woodhouse, British Association, September, 1903.

‡ Messrs. Brown, Boveri have developed a reverse current circuit-breaker similar in type to their overload circuit-breaker. The introduction of a reliable reverse current relay will also solve the problem of cutting out a faulty feeder from the sub-station end where two or more feeders feed one sub-station.

Having installed all the above instruments, the only item necessary to complete the equipment, required for accurate special tests is a water resistance to absorb the energy generated by the plant under test. It is worth while providing permanent arrangements for connecting this water resistance to any generator at will.

To sum up, complete *permanent* apparatus should be provided for taking all necessary tests, thus avoiding the unreliability and uncertainty of makeshift arrangements.

CONCLUSION.

In discussing the general principles governing power station design, and in illustrating their application to certain parts, we cannot pretend to have dealt with all the components which go to make up a complete power station, since however much the designer may endeavour to simplify the problem it still remains a complicated grouping together of apparatus. The parts of a power station to which we have not particularly referred are the boiler house equipment and the piping systems. Throughout we have avoided discussion of the actual design of individual pieces of apparatus (such as the boiler, the steam turbine, or the dynamo) this being rather a question for the manufacturer than for the designer of a power station. The function of a power station designer is to choose from standard apparatus that which best fulfils the conditions to be met, and to assemble it in the most economical way. It is only by a rigid application of this principle to the individual parts that the essential condition of low capital cost can be complied with.

If any excuse be necessary for calling attention (at perhaps too great length) to well-known principles, it must be found in the fact that the success of power supply on a large scale depends entirely upon their being correctly applied to all the component parts of a power scheme. Electrical energy from public supply as against the provision of isolated plants is possible in this country with its relatively dense population in a way that is not possible in America or on the Continent—where industrial centres are separated from each other by wide tracts of country. Although in many ways disappointingly late, realisation during the next few years of our almost unique position in this respect is likely to have a marked effect both industrially and socially.

The discussion was opened by Mr. J. H. BARKER, who was of opinion that the author's figures for cost of plant per KW. were rather high, and those for redemption are also somewhat uncertain. He could not agree to the indiscriminate use of automatic appliances, and thought that the 1,500-KW. turbine mentioned by the authors had hardly received justice as it was quite equal to 2,000 KW. and more, but the leakage loss remains practically constant at all loads. He asked as to the power required to lift the condensing water from the River Tyne, which he thought would be very great.

Mr. J. H. ROSENTHAL thought that the paper summed up the position in which appliances for producing electrical energy stand at the present time. He commented on the low capital cost at Carville, and mentioned that the Metropolitan Railway power station in Paris was practically a copy of it. He complimented the authors on the arrangement of plant.

Mr. G. L. ADDENBROOKE commented on the importance of the turbine in power work as it greatly affects the capital cost, which in turn affects the total costs of supply. Condensing water was a serious matter in a large power station, but was not dealt with in the paper. He pointed out that the cost curve was not quite accurate as regards coal, and did not include administration. It was also important as to whether the table covered units generated or units sold. In regard to gas engines, the coal bill was less, but capital cost was greater, and labour and administration about the same. If the saving in coal was realised, the result would make about 6 per cent. difference in the price of supply to the consumer, or if the price remains the same, say 1 per cent. in dividends to shareholders. With a supply of cheap coal as at present, there was no great opening for the gas engine.

Other speakers advocated the claims of the gas engine, in regard to which large firms were prepared to offer specific guarantees in regard to fuel consumption, &c.

Mr. B. M. JENKIN remarked that it was an expensive matter to change the location of a generating station after the feeders were in position, this, of course, restricting the location. He agreed with the relative position of the boilers and engines advocated by the authors, but could not wholly agree as to each generator having its own distinct set of boilers, as, in case of the generator failing, its boiler plant would also be useless. He thought the boiler house should be complete in itself, although there was something to be said on both sides of the question. He agreed with Mr. Merz's ideal of distinct pipe and cable runs, and described other arrangements of steam pipes equalling in efficiency the arrangement of steam pipe line at right-angles to the engine room. The question of spare plant was not sufficiently emphasised; the authors dealt with it by providing for large overloads. When units got large, it was risky to work with only one spare set. He was in agreement with the provision of roomy switchboards, and only demurred to the position of the bus-bar change-over switches, as no one in front of the board could tell how they were set. He preferred mechanical control of the main switch to electrical, as it was more reliable. It had been impossible up to now to obtain an automatic switch with human intelligence.

Mr. E. W. COWAN submitted a list of the failings of the oil-break switch, which was not the ideal under all circumstances. The ideal switch was one which gradually reduced the current to zero before breaking, and did not give rise to a drawn out arc. Horn break switches have a tendency to break the circuit when both field and current are at a maximum. Another type of switch with some good features quenched the arc under water. Automatic contrivances were often specified to save labour; they really gave reliability, and their failures were often due to neglect. The isolation of switchgear was a step in the right direction, but the screens must be able to withstand the temperature of the electric furnace.

Mr. A. H. DYKES considered that the gas engine had not received fair treatment by the authors. Although the future of the large station probably rests with the steam turbine, yet the diminished fuel costs and saving by residuals in gas engines cannot be overlooked. The labour cost over the whole of a gas station would be much less, and the repairs not necessarily higher than in the case of a steam station. He was putting down a gas engine plant, consisting of four 250-H.P. engines, which, on cheap fuel, were guaranteed to run on 1·63 lbs. per KW.-hour. The capital cost of gas plant had been much reduced during the last few years—the cost of the above gas engines and generators was £13 per KW., and including the producers, £18 per KW. These figures for small plant compare very favourably with steam plant. The cost of buildings is very much reduced, and the exhaust gases can be utilised for water heating. It was also possible to provide overload capacity in gas engines if required.

Mr. W. GEIPEL referred to a paper of Col. Crompton's some 10 years old, in which he showed that a unit could then be generated for 3d., and the effects of capital charges and coal bill on this figure were there discussed. He disagreed with the authors' statement that capital charges were minor considerations in the early days, his 24 years' experience was that it had always been a difficulty to reduce capital cost sufficiently to enable an effective competition with gas to be maintained. With regard to the authors' curves, showing cost of coal, working expenses, capital charges, &c., he referred to an ideal table of costs, suggested by him at the time of Col. Crompton's paper, and which comparison showed were practically the same as those given by the authors, allowance being made for their costs not including distribution. Referring to the use of turbines, an important point, not mentioned by the authors, was the fact that the feed water had no oil in it. He agreed with the authors' views as to the necessity of having short steam pipes, but thought the Carville station steam pipe lines were as long as they possibly could be. Much shorter pipes could have been obtained by dividing the boilers and engines into independent sections. He did not see any difficulty in arranging the turbines more or less opposite their own boilers, and went on to discuss the possible arrangements. He agreed with the authors' conclusions as to using electrical auxiliaries, and thought they formed an excellent example to prospective consumers. The authors refer to the difficulties of time circuit-breakers; he suggested a method probably known to many, *i.e.*, to have a time-fuse for protecting the smaller excess currents and a circuit-breaker with an extra excess or rush of current which would go instantly.

Mr. L. ANDREWS said that the reverse circuit-breaker of the type mentioned in the paper was very susceptible to drops in pressure; in all alternating cut-outs the series current acts inductively on the shunt, and neutralises its action. It was quite possible to make reverse circuit-breakers for use with direct current, if there was no pressure, but this was not possible with alternating current. They had, however, succeeded in producing an alternating cut-out which was reliable with 75 per cent. drop in pressure. He criticised the use of reverse current breakers on duplicate feeders, as they were not reliable.

COL. CROMPTON considered that the authors had hardly done justice to the pioneers of electrical power work, and had also barely referred the use of gas engines for generating purposes. The small gas engine station up to 1,000 H.P., was cheaper than the steam station, but for large powers steam was still unrivalled. He thought that the turbine principle would be eventually applied to internal combustion work. In his opinion engineers had been blind to the advantages of water-tube boilers, correct boiler setting, superheated steam, and perhaps thermal storage, the latter would greatly reduce boiler capacity and capital cost.

Mr. W. H. BOOTH inquired what was the efficiency of a power station? the authors gave the power station an efficiency of not more than 10 per cent. He referred to the influence of load factor on the design of stations and the methods usually adopted for dealing with variable loads in lighting stations. In traction stations the loads were fairly constant all day. He thought it might be advisable, with a view to reducing first cost in certain cases, to install single engines rather than compound, the former working (perhaps uneconomically) with a late cut-off at heavy loads. In regard to duplication, he believed rather in putting in good plant, singly. Mechanical stokers preserved the boilers, and prevented cooling of the flues and apparatus in the latter, they also prevented heavy smoke. The boiler settings generally used for bituminous fuel, were very bad. Superheaters were, he considered, no good in combination with water-tube boilers, but separately fired they had many advantages, and when properly controllable and constructed, they could be used with advantage with existing boiler plants.

Mr. E. K. SCOTT criticised the authors' arrangement of turbine plant, the comparatively large space occupied by the boilers was sufficient, in his opinion, to turn the scale in favour of gas generating plant, and in regard to the latter, the gas turbine was, he thought, the coming thing.

Mr. J. J. STEINITZ considered that engineers had not appreciated the relative importance of capital cost and selling price. The provision of overload capacity in generating plant, did not appreciably increase capital cost, if economical working at overloads was not specified. The authors' figure of £40 per KW. for plant and buildings, was, he thought, rather high. Basements in stations, contrary to the authors, he had found exceedingly useful.

Mr. W. L. MADGEN put the ratio of gross revenue to capital expenditure at 12½ per cent., and out of this, all financial charges had to be met, so that it was of great importance to reduce capital invest-

ments and increase that ratio. The question as a whole was, however, not so much what one could achieve with one generating station as what would accrue from a reduction in the number of generating stations.

Mr. A. Venning mentioned a power station equipped with steam turbines, where the capital cost was £14 per kw., the buildings costing £2 per kw. He did not think these figures would be much reduced. He could not agree with the authors' proposals in regard to coupling up the generating units to independent boiler plants. He critised the authors' design of the Neptune Bank station, and pointed out that local regulations largely controlled the selected design of station buildings. The arrangement of batteries of boilers at right angles to the engine house, and the provision of separate office buildings, was borrowed from American practice. It was usually cheaper and more convenient to provide a basement, rather than a series of foundations and trenches. With cheap coal—4s. to 6s. per ton—it didn't pay to put in an economiser, although it probably did at 15s. per ton. He pointed out that turbine foundations would increase in cost with the adoption of more concentrated designs and weights.

Mr. W. H. Patchell pointed out that actual figures of running and capital costs of the authors' plant were missing, and that fuel costs would be much higher in the South of England. Basements were nearly always cheaper than dug-out foundations and trenchwork.

Mr. Leach asked for the figures on which the authors' curve was based, he thought that reciprocating engines would also give very good results. Superheating was a good thing, and machine stoking gave the best average results.

Mr. C. H. Merz, in replying, reminded his hearers that the paper dealt with the principles of "power station" design. The published costs per kilowatt were not of much value, owing to the variable nature of the plant embraced—the cost per kilowatt at Carville was much below £20. The advantages of the right angle arrangement of boiler house disappeared when small generating units were employed. He agreed with Mr. Steinitz as to the value of overload capacity in generating plant, it helped in the reduction of capital costs. Two spare units were not necessary under ordinary power supply conditions, the overload capacity covered this. He believed economy of capital possible, by operating auxiliaries direct from the generating unit. Overload and reverse current relays, to fulfil the ordinary requirements were not on the market.

REGULATING IMPEDANCE COILS.

By C. F. Proctor, Member.

(*Abstract of Paper read at Newcastle, February 29th*, 1904.)

It is now some years since I was asked to devise a method of regulating a current between the limits of 0·3 to 1·5 of an ampere and 0 to 300 volts, or as near these limits as possible. The method adopted was an alternating current of 375 volts, and a regulating choking coil consisting of about 3,000 turns of ·03 in. D.C.C. wire wound into a coil 6 in. long and 4 in. diameter, and regulated (between 0·2 and 1·0 ampere, 0 to 350 volts) by having a core composed of a bunch of iron wires about 1·5 in. diameter and 14 in. long drawn in or out of the hollow fibre tube on which the coil has been wound (see figs. 1, 2, 3 and 4). Some years later more coils were made, but the results were so unsatisfactory that the coils were sent to me to report on and advise how to correct them.

When the first coils were made, I questioned the somewhat large diameter of the coil as compared with its length, and also the want of a return magnetic circuit. I experimented further, and found that by adding a return magnetic circuit the choking effect of the coil could be almost doubled. Coil B_1, I believe, is of about the best proportions.

The coils should be somewhat longer than originally constructed, since the ampere-turns per lb. of wire increase more rapidly by adding to the length rather than the diameter. Coils B_1 and B_2 have exactly the same weight of wire on them, but B_1 has 2 550 turns against 2,300 of B_2; but any further increase in the length seems to again decrease the efficiency. The weight of wire on these two coils (Table I.) is just two-thirds of that used in the first coil, P small, and the choking effect is quite as good. The core used in the experiments with the coils P small and P large, also the coils B 6½, B 5 and B compound, consists of a bunch of iron wires 21 in. long, 1·20 in. in diameter, and weighs 4 lbs. 10 oz. The exterior iron wire return magnetic circuit consists of a number of small bunches of the same sized wires held together with string, making a band 13 in. wide and 10 in. long, and weighs 3½ lbs.

On referring to Table I., P large, it will be seen that the effective resistance is so great that only 1·3 amperes pass with a P.D. of 400 volts, although the actual resistance is only 70 ohms.

Coil J, which is one of the second batch of coils made, is 8 in. long, somewhat rectangular in section, is wound on a split sheet-iron sheath, insulated by a mica sleeve, and has only 1,540 turns of wire; the core is made up of strips of sheet iron, its short-circuit current is above 5 amperes, and its maximum regulation as at first constructed,

Table No. I.—Table of Dimensions and Ranges.

Coils.	Length of coil.	Diam. of coil.	Weight of wire.	Diam. of core in coil.	Diam. of iron core.	Resistance in ohms.	Total turns.	Amperes passing on short-circuiting across 400 volts. Core in.	Core out.	On a 400-volt circuit the volts available for regulation at the following amperes are: 1 amp.	0·75 A.	0·50 A.	0·20 A.
P small ...	6·25	4·00	8 lb. 5 oz	1·625	1·20	37	3,000	0·21 A.	2·90	354 V. to 0 V. at ·21 A	360 V. to 0 V. at ·21 A	381 V. to 0 V. at ·21 A	385 V. to 0 V. at ·21 A
P large ...	6·25	5·50	12 lb.	2·00	1·20	70	5,000	0·10	1·30	225 V. to 0 V. at ·1 A	310 to 0 V. at 0·1 A	360 to 0 V. at 0·1 A	—
J... ...	8·00	2·25 sq. in.	2 lb. 4 oz	1·25 sq. in.	1·20	10	1540	Too high for size of wire above 5 A.	Too high for size of wire above 5 A.	376 to 326	380 to 345	—	328 to 375
B 6½ in. ...	6·5	3·25	5 lb. 7 oz	1·625	1·20	25	2,550	0·22	5·0 A.	373 to 0 V. at ·22 A.	379 to 0 V. at ·22 A	—	391 to 0 V. at ·22 A
B 5 ...	5·0	3·50	5 lb. 7 oz.	1·625	1·20	25	2,300	0·23	5·0 A.	373 to 0 V at ·23 A.	379 to 0 V. at ·23 A	—	391 to 0 V. at ·23 A
B ... compound	6·50 + 1·75 = 8·25	2·8	—	1·75	1·20	17 plus 5 = 22 total	2,300 + 500 = 2,800	0·3	Too high for size of wire above 5 A.	—	—	—	—
								0·22					
B 100 volts	5·0	1·5	1 lb.	0·85	0·75	5 terminals 0·9 ohm each 4·5 ohms.	1000	—	—	—	—	—	—

with a current of 1·5 amperes passing and an E.M.F. of 400 volts, is 383 volts to 306, or 77 volts. The difference between the 400 volts and the 383 is loss by effective resistance. At 0·3 ampere its regulation is only 400 volts to 386. Reference to Table II. will show what a very great improvement can be made in this coil by

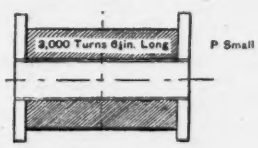

Fig. 1.

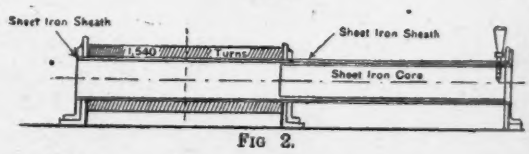

Fig 2.

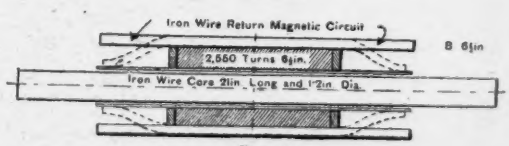

Fig. 3.

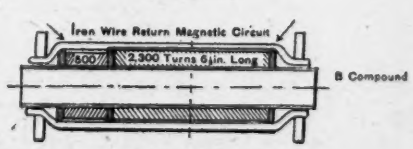

Fig. 4.

removing the iron sheath and adding an exterior magnetic circuit; at 0·3 ampere the regulation is more than three times what it was, and at 1·5 amperes more than twice what it was.

The regulating booster transformer used for the experiments, consists of one circuit only, of 450 turns of ·054 in. diam. D.C.C. wire, on which have been placed split sheet-iron rings in the same manner as usually adopted for transformers. The 450 turns of wire are divided thus:—

TABLE II.—COIL J AS CONSTRUCTED, AND AS ALTERED, COMPARED WITH COILS P AND B ON A 400-VOLT CIRCUIT.

Coil J as at first constructed.	Loss in volts by effective resistance at 0·3 A.	0·75 A.	1·00 A.	1·50 A.	Range in volts at various amperes. 0·3 A.	0·75 A.	1·00 A.	1·50 A.
With iron sheath and without iron wire return magnetic circuit..	18	20	24	33	7	35	50	90
J without sheath and with return magnetic circuit	3	9	10	18	25	85	110	150
Coil P small	15	40	46	—	385	360	350	344
Coil B 6½	9	21	27	36	391	379	373	370

Terminal No. 3, then 300 turns, and terminal No. 1, then 70 turns more, and a connection to the first of the switch contacts, and at intervals along the last 80 turns there are 20 connections made, one going to each of the switch contacts. The end of the last coil is joined to terminal No. 4. Terminal No. 2 is joined to the switch handle. On joining a primary of 100 volts to terminals Nos. 1 and 2, between terminals 3 and 4 we can obtain any E.M.F. between 300 volts and 640 volts—*i.e.*, 70 turns into 450 × 100 = 640 volts, or 70 + 80 into 450 × 100 = 300 volts—and by varying the connections of the secondaries, almost any voltage from 0 to 500 or 700 volts can be obtained (fig. 5).

As regards the uses to which the coils can be put, the first and most obvious is for the regulation of lights in theatres, where often 300 to 400 lamps must be turned up or down without any perceptible jumps. With an impedance coil, 80 to 90 per cent. of the current usually absorbed by the resistances would be saved, and the trouble often experienced with liquid resistances would be avoided; but, of course, alternating currents would have to be used.

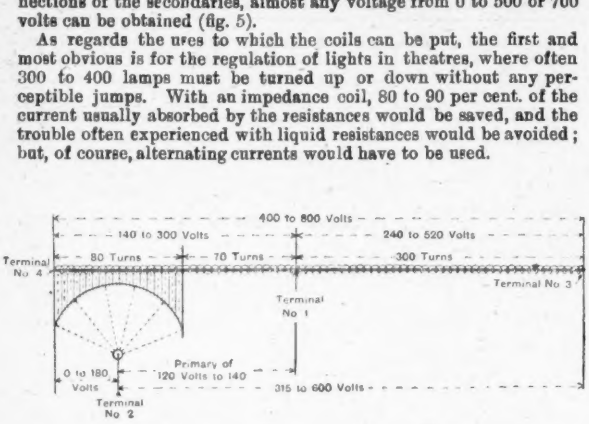

FIG. 5.—DIAGRAM OF REGULATING BOOSTER TRANSFORMER. WINDINGS AND VOLTAGES OBTAINABLE.

The coils might also be used for regulating the luminosity of an incandescent lamp; for example, a person on a 100-volt circuit may buy 90-volt lamps, and choke down the voltage to suit. The 10 volts would probably be sufficient to compensate for potential irregularities, and at the same time, as lamps lost their brilliancy, the E.M.F. could be pushed up again by the coil.

BIRMINGHAM SECTION.

THE report of the Committee, submitted to the annual general meeting held on May 18th, shows that the membership had increased from 199 to 258. The officers for the 1904-5 session are:—

Past-Chairmen—

Sir Oliver Lodge, F.R.S. (1900-2) Henry Lea, M.I.C.E. (1902-3)
J. C. Vaudrey, M.I.C.E. (1903-4)

Chairman— W. E. Sumpner, D.Sc.

Vice-Chairman— R. Threlfall, F.R.S.

Ordinary Members of Committee—

R. A. Chattock	R. C. Jackson	W. O. Rooper
T. Hawkins	J. H. McLean	C. E. C. Shawfield
S. H. Holden	R. K. Morcom	A. M. Taylor
R. H. Housman	R. Orsettich	

Hon. Secretary— D. K. Morris

Assistant Hon. Secretary— J. K. Catterson-Smith

MANCHESTER SECTION.

THE report of the Committee for the fourth session (1903-4) shows that the average attendance at the meetings was about 187, as against 118 last year. The membership of the Section shows a large increase on previous years, the total being 549, as compared with only 472 a year ago. The Committee for the session 1904-5, elected at the annual general meeting on April 12th, 1904, is as follows:—

Past-Chairmen—

Dr. Edw. Hopkinson Hardman A. Earle
C. H. Wordingham Edw. W. Cowan

Chairman— C. D. Taite

Vice-Chairman— A. S. Giles

Members—

L. Andrews	A. Bromley Holmes	M. B. Mountain
Dr. F. H. Bowman	F. A. Cortez Leigh	S. L. Pearce
A. A. Day	G. F. Metzger	Dr. W. G. Rhodes
A. H. Gibbings	T. L. Miller	Dr. Schuster

Hon. Secretary and Treasurer—

P. A. Ramage, Gardner Road, Prestwich, Manchester.

AUTOMATIC PROTECTIVE DEVICES FOR ELECTRICAL CIRCUITS.

(*Concluded from page* 935.)

Alternating Current Discriminating Device.—It will be seen (fig. 7) that the device consists of a transformer wound with two primary and two secondary windings. One of the primaries, usually consisting of one turn, is connected in series with the circuit to be controlled. A current in this winding tends to produce a flux in the centre core of the transformer which divides equally between the two magnetic return circuits, and cuts the two secondary windings equally. As a consequence the coils of the relay will both be equally energised, and the core will neither be pulled up nor down. The potential primary windings tend to produce a flux which flows round the outer magnetic circuit, avoiding the centre path. This flux will also tend to cut the two secondaries equally. If, now, you consider the combined effect of the fluxes due to the two primaries you will see that the fluxes in the upper half of the transformer oppose each other, whereas those in the lower half assist each other, and, as a consequence, the core is forcibly held down. These conditions will be maintained so long as the generator supplies current to the bus-bars. Should the direction of the series current become

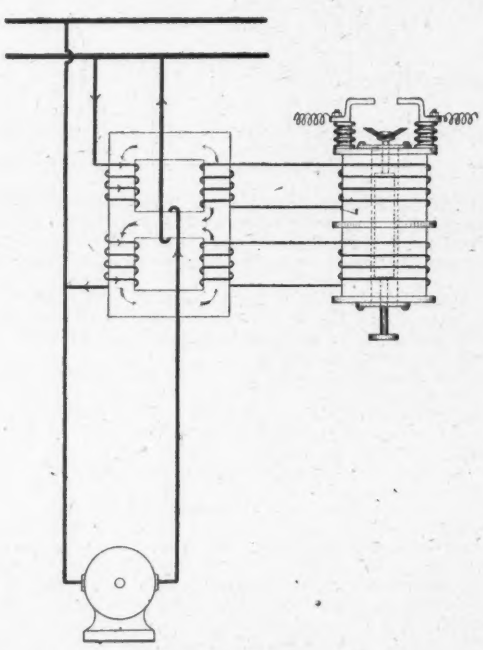

FIG. 7.

reversed relatively to that of the shunt, the fluxes in the lower half of the transformer will oppose each other, and those in the upper half will assist each other, with the result that a much heavier current is induced in the upper secondary than in the lower secondary, and the core is pulled up until it closes the local circuit and operates the cut-out.

We usually connect, in parallel with the respective windings of the relay, a red lamp across the upper secondary and a green lamp across the lower. These lamps indicate at a glance the direction of the current; they also give an approximate indication of the amount of current flowing in the generator circuit, and they give a constant indication that the apparatus is in working order. If, for instance, an open circuit occurred in the shunt winding, both lamps would glow equally on a full load current, whereas without this indication the device might be left for some days before the defect was discovered, and if the generator controlled failed in the meantime, the automatic device would fail to serve as a protection. Another argument in favour of using the lamps in conjunction with this device is that the operation of any relay device depends, to a certain extent, upon the relay contacts being kept clean; should this happen to be overlooked and the relay fail to close the local circuit, the attendant has always a correct indication as to which generator is failing, and he can, in consequence, operate the circuit-breaker by hand. The indicator is shown in fig. 8.

The experimental apparatus shown consisted of a discriminating transformer of the type described, mounted on a panel fitted with an oil break circuit-breaker with loose handle attachments, and with a relay and trip gear. An ammeter connected in the series circuit showed the current flowing in the series circuit, while a voltmeter connected across the shunt windings indicated the pressure applied. It was demonstrated that the device worked with absolute reliability on a drop of pressure of 75 per cent., that is to say, on 25 per cent. of the normal pressure. With a full load forward current on (200 amperes) the green lamp glowed at full brilliancy, and there was a strong pull holding the relay in an open position. When the direction of the main current was reversed, the green lamp was extinguished and the red lamp glowed, and when the reverse current attained the value of 50 amperes, at which the cut-out was set to operate, the relay was pulled over very decidedly, closing the local circuit and instantly operating the circuit-breaker. With a pressure 50 per cent. of the normal, the cut-out operated with a reverse current of 50 amperes, and on again reducing the pressure to 25 per cent. of normal, the cut-out still operated, with a reverse current of 200 amperes.

The strength of the current in the shunt winding is entirely unaffected by a heavy current in the series winding. It will be seen on referring to fig. 7 that the flux due to the series winding tends to boost one half of the potential primary and retard the other half, and as these two windings are in series the effect is neutralised.

Protection of Duplicate Feeders.—Although the type of cut-out referred to above will, apparently, deal satisfactorily with any breakdown that is liable to occur at the generator board, it cannot be considered in all cases absolutely reliable for use at the distributing end of duplicate feeders, to prevent the current feeding back from the healthy feeder into a faulty feeder. It is practically impossible to make an alternating current discriminating cut-out work reliably with no potential across the shunt primary. Such

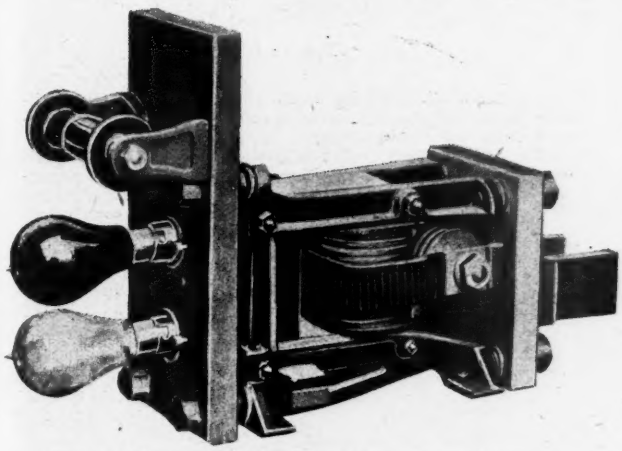

Fig. 8.—Current Direction Indicator as made to replace Generator Fuses.

very severe conditions are not liable to arise at the generating end of the line, and in cases where sub-stations are fitted with motor-generators and batteries, there will probably be no difficulty in maintaining sufficient pressure across the bus-bars to operate a reverse current circuit-breaker. In cases, however, where duplicate feeders are used for feeding sub-stations containing stationary transformers only, there is always a risk that, in the event of a low-resistance short-circuit appearing near the sub-station, the fall of potential will be so great that no discriminating cut-out can possibly deal with the difficulty. We realised some two years ago, at Hastings, that this problem must be tackled in a totally different manner.

As a rule feeders are inter-connected at the sub-station end through bus-bars only, and, as a consequence, there is practically nothing to limit the flow of current to the faulty feeder. If, instead of this, the feeders are connected through a choking coil wound entirely in one direction, with the supply to the sub-station tapped off the centre of the choking coil, under normal conditions the current will divide equally between the two feeders, and will flow round the two halves of the choking coil in opposite directions, and, as a consequence, this coil will be entirely non-inductive. Now, should one of the feeders break down, the fuse at the generating end of this feeder will be blown, and current will flow back to the fault from the healthy feeder at the sub-station end through the choking coil entirely in one direction; this will, in consequence, now become highly inductive, and will limit the flow of current to anything desired. The current flowing to the fault may be reduced to 1 per cent. of the full load current or even less. This would, however, entail the use of a very large choking coil, and would hardly be commercial. In most of the installations of this device we now have in hand, we are making the choking coils to limit the flow of current, to the fault, to 25 per cent. of the full load current. The healthy feeder has therefore only to carry 25 per cent. over the normal full load, even if the fault is left on for some considerable time, and therefore if the faulty feeder is not completely cut off for, say, half an hour, no damage will be done to the healthy feeder, and there should be no risk of its fuse or excess current circuit-breaker being operated.

As the supply pressure cannot under any conditions drop below 50 per cent. of the normal, the difficulty of constructing automatic circuit-breakers is entirely overcome. One method of automatically operating these circuit-breakers is shown in fig. 9. It will be seen that this is an adaptation of the pendulum device referred to earlier. The series winding is in this case connected between the two feeders; as, however, there is normally no difference of potential between these feeders there will be no tendency for current to flow from one to the other. Should one of the feeders break down, current will flow from the healthy feeder through the series coils of the relay to the faulty feeder, and as this current will have a sense of direction relatively to the shunt winding, the relay will close the local circuit controlling the circuit-breaker on the sub-station end of the faulty feeder. The cross connections shown on the diagram are provided to maintain the choking coil non-inductive when one of the feeders has been cut off and the supply continued through the remaining feeder only.

The experimental apparatus shown consisted of model duplicate lines terminating in fuses at one end and in an oil break circuit-breaker, controlled by a relay as described, at the other end, a small discriminating choking coil being used to connect the lines together. The oil break circuit breaker has been specially designed for this purpose; it is not dependent upon delicate catches, and is consequently not likely to operate when not required to do so. As a further precaution the two switches are so interlocked that when one of the switches has been automatically opened it is impossible for the second switch to be released; therefore, there is no risk of the two switches being opened simultaneously, and the supply being interrupted. On connecting either of the lines to earth the fuse, at what corresponded to the generating station end of this line, was blown, and the pressure across the lamps momentarily dropped to 50 per cent. of the normal. This drop of pressure only lasted for a fraction of a second, as immediately the switch had operated the full pressure was again restored.

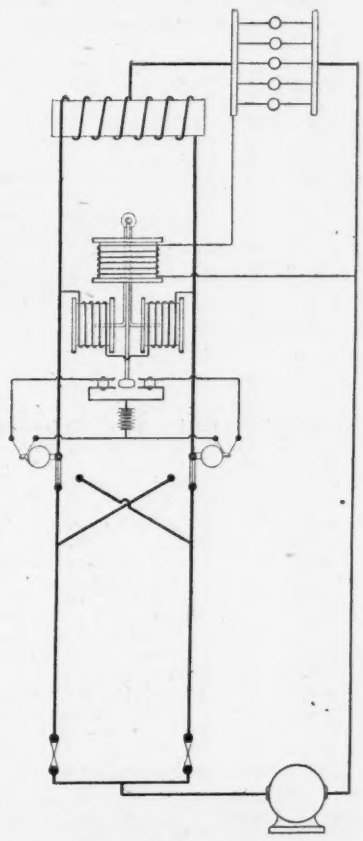

Fig. 9.

Time Element Devices.—There has been a great tendency, particularly during the past few months, to use magnetically operated excess circuit-breakers on H.T. transmission lines in place of fuses. It is, however, universally recognised that a magnetic circuit-breaker is not complete without some time element device to delay its action in inverse proportion to the amount of the excess current.

One of the first devices introduced for this purpose was a clock-work device which was set in motion by an excess current, and was arranged to close a local circuit and thus release the circuit-breaker if the excess current was maintained beyond a predetermined time. A serious defect in this device was that it was impossible to accelerate it, and as a consequence serious injury was done by keeping connected to the supply a short circuit that was possibly taking an overload of several hundreds per cent.

The characteristic curve of this device is represented by a long horizontal line at the top of fig. 10. In this diagram it will be seen that this device operates with a 25 per cent. overload in a given time, but it takes equally long to operate with an infinitely greater overload.

In a later improvement a time element device was constructed to operate with any excess current from 25 per cent. to 100 per cent. overload in a given time. This result was obtained by the use of auxiliary weights. These auxiliary weights were lifted by a solenoid energised by a local circuit if the overload was only maintained for a given time, but were lifted instantaneously by a main solenoid if the current in this exceeded, say, 100 per cent. overload. The device was, however, somewhat complicated, and does not appear to have been largely used. Various attempts have also been made to use ordinary liquid or air dash pots, applied in various ways to delay the operation of the circuit breaker. A difficulty that has arisen with these devices has been that, after standing in one position for some months, they are liable to stick there when required to operate.

An ingenious device for this purpose has recently been put on the market by Messrs. Brown, Boveri. This device is practically a wattmeter arranged to wind up a weight and close a local circuit. The rate at which the weight is wound up decreases as the current increases. It will be seen, however, from the characteristic curve of this device that an increase of overload beyond a certain amount does not appreciably accelerate its action, and even on an overload current of several hundred per cent. it will take two or three seconds to operate. Even this device, therefore, does not quite meet all the requirements. It is, we think, essential that on an overload exceeding a certain amount, the device should operate as instantaneously as a fuse does. A method of obtaining this result is shown in fig. 11; this apparatus consists of a vessel containing mercury and some

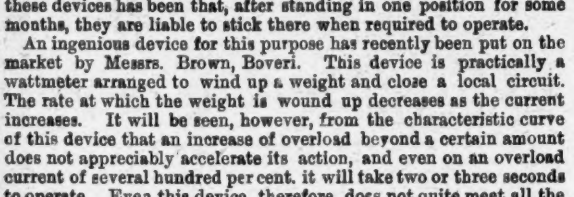

Fig. 10.

lighter liquid, such as oil. A miniature diving bell directly attached to the operating core is immersed in the mercury. This diving bell is divided into two compartments by a thin diaphragm, and communication is established between the upper and lower compartments through a small hole in this diaphragm. A second hole is also made in the upper portion of the diving bell. It is obvious that a certain current will be required in the solenoid to overcome the weight of the core and diving bell. If the core is lifted slowly the air pressure on the top of the liquid in the diving bell will be equal to the pressure in the outer containing vessel, and as this pressure will be transmitted through the oil to the mercury, the level of the mercury on the inside will equal that on the outside. If, however, the core is lifted more rapidly, the liquid, passing through the small hole in the diaphragm, is wire drawn, and as a consequence the pressure inside the diving bell will be considerably less than that on the outside, and a column of mercury will be added to the weight of the diving-bell, the height of this column depending upon the rate at which the core and diving-bell are lifted. If the core is lifted instantaneously none of the light liquid will have time to flow through the diaphragm, and as a consequence a vacuum will be produced in the diving-bell on the underside of the diaphragm and the whole of the mercury in this will be lifted instantly. It may appear, at first sight, that the apparatus would work equally well without any liquid over the mercury. This would, however, entail the use of such a very small hole in the diaphragm that there would be a risk of this becoming obstructed by particles of dust, and it does not appear that such a wide range could be obtained with the arrangement shown.

An experimental apparatus, consisting of a glass containing-vessel and glass diving-bell, was connected up, and when a current of about 10 amperes was switched on the diving-bell lifted very slowly and took several seconds to travel through its whole range. Upon increasing the current to 15 amperes the movement was greatly accelerated, but it still took quite an appreciable time to travel through its whole range; but when a current of 30 amperes was switched on the core with the diving-bell full of mercury was lifted instantaneously.

General Arrangement of H.T. Switchgear.—Ideas as to what is the best general arrangement of H.T. switchgear have undergone a complete change during the past few months. The introduction of the Ferranti type of switchgear some years ago was such a marked advance upon the ordinary double pole flat back switchboards that it almost appeared that there was no room for further improvement. Experience has, however, shown that, excellent though this type of gear is in many respects, it possesses, nevertheless, some

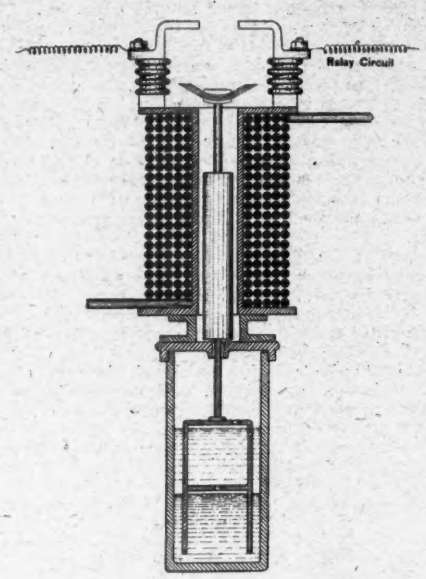

Fig. 11.

weak points, which must be removed before that absolute reliability which is required in connection with the control of important undertakings can be attained.

After visiting many of the large power installations in this country, on the Continent, and in the United States, for the purpose of collecting information upon this subject, we have come to the conclusion that an ideal switchboard would be a combination of the simplicity and absence of small wires peculiar to the English practice, with the complete isolation and fireproof construction of the American practice, and with the mechanical remote control of the Continental practice. Fig. 12 illustrates an arrangement embodying these principles. The cables from the generators or feeders should be run in separate fire-proof pipes in a

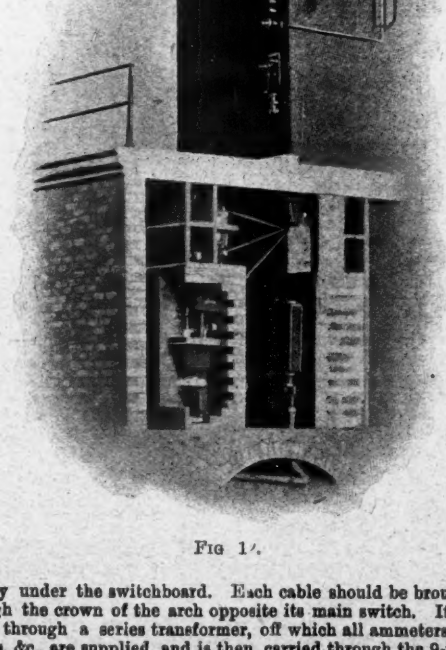

Fig 12.

subway under the switchboard. Each cable should be brought up through the crown of the arch opposite its main switch. It is first taken through a series transformer, off which all ammeters, wattmeters, &c., are supplied, and is then carried through the 9-in. wall directly to one terminal of the main circuit-breaker. This arrangement entirely prevents the risk of spread of fire through the cable connections. Each circuit-breaker is placed in a separate compartment, isolated from adjoining compartments by a 4½-in. brick wall,

and it is further enclosed by an iron damper door. As the fixing of the circuit-breakers in narrow compartments would tend to make them somewhat inaccessible for cleaning purposes, this difficulty has been overcome by mounting each breaker on a carriage supported by brackets fixed to the walls. Extension rails are provided to fix to any pair of brackets, and the circuit-breaker may thus be withdrawn bodily from its position in its compartment. By this means all parts are perfectly accessible for cleaning, &c.

In the arrangement shown all the H.T. gear is fixed on the ground floor, and the switches are operated through mechanical connections from the gallery above. All rheostats and L.T. instruments are placed on this gallery.

These H.T. switches are arranged in two distinct rows, the operating gear leading to the right and to the left from the operating panels. By this means only half the width is required for the panels that is allowed for the switches. If desired, two more rows of switches may be arranged on another gallery over the operating gallery, in which case the width of the operating panels will be only one quarter that of the switches. It will thus be seen that all the advantages of the American electrically-controlled system may be obtained without the complication involved by the latter.

In a modified arrangement the H.T. switches are placed on the same floor as the operating panel, directly behind it. This arrangement is perfectly satisfactory for comparatively small installations.

In all H.T. schemes provision should be made for isolating the oil switches, &c., from the bus-bars for overhauling, &c. This entails the use of selector switches or plugs, which cannot be constructed to break a heavy current. There is, however, always a risk that one of the plugs or switches may be opened with load on and a serious arc started. To prevent this arc spreading to the bus-bars or to adjacent sections, we have arranged the break of each selector switch or plug in a separate compartment, isolated from adjacent sections by 4½ in. walls and from the bus-bars by thick soapstone slabs. The bus-bars are also enclosed in a separate compartment.

INTERNAL COMBUSTION ENGINES AND THE DIESEL PRINCIPLE.

By W. H. BOOTH.

It is a pity that in his James Forrest lecture Mr. Dugald Clerk should apparently have confined his remarks so much to those engines which are of home origin, because by doing so he omitted much reference to such engines as the Körting, which owes its success to a system of working, the credit of which belongs to Mr. Clerk, and to the Diesel engine, which stands out from all others as the outcome of the latest ideas in internal combustion motors.

It has been pretty conclusively shown that economy in the gas engine attends on high compression, but practice has shown equally conclusively that high compression of an explosive mixture has a low safe limit.

The compression of a gas requires the expenditure of energy, and this energy in the case of a perfect gas is converted entirely into heat energy, and manifests itself by rise of temperature. In a slowly running engine much of this heat could and would pass into the water jacket, and so far would be lost for useful work in the engine. Compressed quickly as it must be in any engine of moderate size per unit of effort, the gaseous mixture becomes heated to a high temperature, and becomes spontaneously explosive. Myself, I have little doubt that spontaneous ignition takes place more readily in the more highly hydrogenous mixtures, and this very real danger shuts out from high compression use the richer gases; and those with much hydrogen in their composition, such as the water gases and the coal gases, are unsuitable to be employed in high-compression engines. Mr. Thwaite, in his blast-furnace gas practice, has found that the very poor gas produced from a blast furnace, and containing very little hydrogen, is a very manageable gas. This may partly be due to its considerable constituent of carbon dioxide, which assists to delay ignition. Suffice it to say, that blast-furnace gas will safely endure an intensity of compression above what can be secured with richer and hydrogenous gas.

Now, in the Diesel engine, compression is entirely independent of the quality of the fuel, for the very simple reason that no fuel is introduced until it is wanted to ignite. Pure air alone is compressed, and therefore the intensity of compression is limited only by two factors—the ability of the mechanical construction to withstand the stresses, and the thermal possibilities involved. The high compression produces a temperature sufficient to cause ignition of the fuel, and this ignition takes place as soon as the fuel is introduced to the heated atmosphere in which it burns.

Thus the Diesel engine does act along very different lines from those casual lines of the ordinary internal combustion motor. Though the full cycle intended to be worked by Diesel has not been found practicable, a part of it has been secured, and combustion takes place on isothermal lines, the diagram of the Diesel engine being simply the compression curve pushed forward by temperature, so that the air occupies a larger volume at the same pressure. Thermally, the advantage of this system is that the maximum pressure may be employed that the machinery will permit, and there can be no pre-ignition. There is no sudden accession of pressure on the dead point, but the pressure may even rise a little after the crank has passed its position of zero effort. In this way, as I have previously pointed out in the Electrical Review, there is less mechanical loss incurred through the imposition of a heavy pressure on the bearings during the time such pressure is producing no turning effort. Where early ignition takes place and produces this effect, much of the heat is passed directly to the water jacket, and therefore wasted. In gas and oil engine work it is of importance that the heat generated by combustion should pass very directly into mechanical work. Every engine is, of course, a compromise between full ignition on the dead point and the longest utilisation of the pressure produced, and prolonged combustion, with a minimum of loss to the jacket. Early and complete ignition not only produces frictional loss, but jacket loss. These losses are both saved by prolonged combustion, which, by purely academic men, is looked on as an error. Hence the importance of securing a satisfactory compromise. In the Diesel system this compromise, combined with the principle involved, enables an efficiency to be obtained as between I H P. and calorific capacity of the fuel of 42, if not 44, per cent., and well over 30 per cent. can safely be counted on, referred to brake horse-power.

There is an impression abroad that the mechanical efficiency of all internal combustion engines is low. This is not strictly true as very commonly understood, and it only arises because so many revolutions are made for one working stroke, which has to carry all the frictional effects of the idle strokes.

As a machine, the Diesel or other engine may be fully as frictionless as a steam engine, and recent tests of a Diesel engine have shown me that this is the case. I have also found that an indicated horse-power-hour can be got for about 0·32 lb. of crude oil with a calorific capacity of about 19,000 B.Th.U., and this points to a very efficient utilisation of the heat value of the fuel. This high efficiency is a result due largely, of course, to the high compression which is possible only with the Diesel system of fuel admission. It is also partly due to the diminished friction and diminished jacket losses referred to, and these advantages may be more or less secured in other forms of engines than the Diesel.

The economies of recent years in internal combustion engines have all tended towards a diminution of jacket losses. Diesel originally hoped to cut off jacket losses altogether, but this has not been proved possible in practice. A very high piston velocity that would diminish the duration of the heat absorption of the jacket and accelerate the conversion of heat into work, would render the jacket dispensable, but these factors are not yet secured to the necessary extent.

The future improvement of internal combustion engines lies so much along the lines followed by Diesel that this motor may be studied to good advantage, for its system of compression removes the most serious limitations of the ordinary engine, and in weight of combustible per unit of energy output its record is far ahead of any other motor.

THERMAL STORAGE.

Owing to increased demand it became necessary in the spring of last year to consider the necessity of increasing the plant capacity at the Kensington and Notting Hill joint station, and the result was that the Halpin system of thermal storage was adopted. It was in reference to what had been effected by this system that Col. R. E. Crompton spoke at a recent meeting of the Institution of Electrical Engineers. Mr. Miller, the engineer of the joint works, had already

adopted the refractory system of setting the water-tube boiler, which has for years past been advocated, indeed, we may say originated, in our columns; and he considered that this would greatly help the thermal storage system.

The system of boiler setting is simply that of preventing the gases rising from the grate surface from passing directly amongst the cold tubes of the boiler. Instead of that the boiler is raised sufficiently high to enable a substantial brick arch to be extended almost to the back end of the grate, thus compelling all the gases from the fuel and the air admitted at the door to mix together as they travel the length of the fire without abstraction of heat. A heavy bridge wall and a return arch turn the gases into the space above the first arch, fully consumed, and ready to be admitted to the boiler tubes. The result is smokelessness, as we have always said it would be, but excepting in this one instance and that of a boiler at the Crompton works at Chelmsford, no engineer has been able to appreciate the system of refractory furnace sufficiently to adopt this means of smokelessness and economy. The thermal storage system adopted is that of large water drums above each boiler. These drums are nearly full of water, which is heated to boiler temperature. Thus the water-tube boiler is given a water capacity more nearly equal to that of the Lancashire boiler, and a practical denial is given at the same time to the supposed danger of large shells which for years has been held up as a strong argument for water-tube boilers. The boiler feed is admitted at the top of the thermal storage drum, and passing through the steam is fully heated to boiler temperature. The store of heated feed is drawn upon at times of heavy load. As stated by Col. Crompton, the boilers when thus fed will deal with double or treble the weight of water that can be dealt with in the ordinary way with warm or economiser water only. There is nothing novel in this. It has long been recognised that an economy can be realised by heating the feed to a boiler by the steam from the same boiler. M. Normand, the French engineer, showed this years ago. Following Col. Crompton at the Institution, Mr. W. H. Booth said he had been urging the same thing for a long time to, he feared, deaf ears. The system of fully heated feed was that adopted in the Cruse superheater, the water heating being incidental to the method of control by an internal pipe of water passing through the tubes of the superheater. Thus the full effect of the thermal storage system could be obtained without any change of the boilers, the water drums of the separately fired superheater storing all that was necessary. The point to be observed, however, was the full heating of the feed water before entry to the boiler.

A boiler is not a fit apparatus to employ as a feed heater. The proper function of a boiler is to boil. Only when fed with water ready to be evaporated can a steady rapid circulation of water be expected, and only when there is such circulation can the somewhat cryptic effects referred to by Col. Crompton be secured. While on the subject of economy of boilers, however, it might not be out of place to say that where a station is filled up with boilers, each doing only half the proper work it should do, it is no very great feat to discover that half the number of boilers can do the whole of the work.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

11,777. "Improvements in or relating to electrical tumbler and like switches." M. Lawton and H. W. Whatson. May 24th.

11,814. "Emergency automatic safety cut-out for overhead electric traction line wires." F. Ainsworth. May 24th.

11,831. "Improvements in gas or vapour electric apparatus." M. von Recklinghausen. May 24th.

11,832. "Improvements in gas or vapour electric apparatus." M. von Recklinghausen. May 24th.

11,842. "Improvements in apparatus for lighting railway vehicles by electricity." H. Wright. May 24th.

11,848. "Improvements in electric igniters for explosion motors." W. Sander. May 24th. (Complete.)

11,857. "Improvements in and relating to electric switches." F. Stevens. May 24th. (Complete.)

11,862. "Improvements in and relating to electric arc lamps." H. J. Haddan. (Firm trading as Allgemeine Beleuchtungs und Heinzindustrie Actien-gesellschaft, Germany). May 24th. (Complete.)

11,873. "Improvements in electrical motor-starting switches." U. Horsfall, J. Crowther and A. G. Brown. May 25th.

11,887. "Rotary switch for electrical conductors." J. Dugdill. May 25th.

11,928. "Draw-off water tap for electric filters." M. Otto. May 25th. (Complete.)

11,930. "Improvements in alternating current motors." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) May 25th.

11,931. "Improvements in electric locomotives." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) May 25th.

11,933. "Improvements in electric rheostats." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) May 25th.

11,943. "Improvements in electric miners' safety lamps." J. P. Rees. May 25th.

11,017. "Improvements relating to electric switches." J. B. R. Swan. May 26th.

12,056. "Improvements in electro-magnets." J. Watson, Jun. May 27th.

12,067. "Improvements in prepayment electrical measuring instruments." F. Conrad. (Date applied for under Patents Act, 1901, June 24th, 1903, being date of application in United States.) May 27th. (Complete.)

12,097. "Improved regulating apparatus for automatically maintaining accumulator charging currents constant" Aktien-Gesellschaft Brown, Boveri & Cie. (Date applied for under Patents Act, 1901, June 26th, 1903, being date of application in Germany.) May 27th. (Complete.)

12,101. "A new or improved electric motor." J. Bonham, H. Rennie, F. Taylor, and K. J. Henderson. May 27th.

12,123. "Improvements in alternating-current electric motors." F. W. Davies. May 28th.

12,136. "Improvements in the manufacture of welded conduit for electric wiring." T. Taylor. May 28th.

12,188. "A method of producing electric energy by the direct utilisation of the chemical energy of any suitable combustible." H. Tourneur. (Date applied for under Patents Act, 1901, June 11th, 1903, being date of application in France.) May 28th. (Complete.)

12,191. "Improvements in and relating to electric controllers, switches and the like." The British Thomson-Houston Co., Ltd., and A. S. Cubitt. May 28th.

12,192. "Improvements in brush holders for dynamo-electric machines." The British Thomson-Houston Co., Ltd. (The General Electric Co.) May 28th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1903.

Apparatus for Automatically Extinguishing Lights, whether Gas Burners or Electric Lights or the like, after they have burnt a given Length of Time. C. D. Abel. (La Compagnie Anonyme Continentale pour la Fabrication des Compteurs de Gaz et Autres Appareils, France.) 6,282. March 18th.

Carbon Holders for Electric Arc Lamps. R. Hamilton-Adams. 6,405. March 19th.

Electric Indicators. E. Sadler. 6,415. March 19th.

Electric Controllers. E. A. Carolan. (The General Electric Co., United States.) 6,483. March 20th.

Alternating Electric Current Transformers. E. A. Carolan. (The General Electric Co., United States.) 6,484. March 20th.

Electric Reactance Coils. E. A. Carolan. (The General Electric Co., United States.) 6,485. March 20th.

Induction Electric Motor Armatures. E. A. Carolan. (The General Electric Co., United States.) 6,486. March 20th.

Electric Switches. E. A. Carolan. (The General Electric Co., United States.) 6,490. March 20th.

Alternating Electric Current Motors. E. A. Carolan. (The General Electric Co., United States.) 6,491. March 20th.

Electric Metering Systems. E. A. Carolan. (The General Electric Co., United States.) 6,493. March 20th.

Means for Controlling the Division of Load between Synchronous Electric Motor-Generator Sets. E. A. Carolan. (The General Electric Co., United States.) 6,494. March 20th.

Dynamo-Electric Machines. E. A. Carolan. (The General Electric Co., United States.) 6,500. March 20th.

Forms for Winding Electric Coils. E. A. Carolan. (The General Electric Co., United States.) 6,501. March 20th.

Electric Coil-Forming Apparatus. E. A. Carolan. (The General Electric Co., United States.) 6,502. March 20th.

Electrolytic Electricity Meter. C. O. Bastian. 6,510. March 20th.

Cradle or Support for the Receiver or Hand Set of Combined Table and Wall Telephones. B. Brander. 6,660. March 23rd.

Telephonic and Signalling Apparatus. J. Higginbottom. 6,671. March 23rd.

Controllers for Electric Circuits. T. von Zweigbergk. 6,718. March 23rd.

Improvements in Electric Road Carriages and Similar Vehicles. E. Diaullette. 6,958. March 24th.

Alternating Electrical Current Meters. A. G. Bloxam. (Luxsche Industriewerke A.G., Germany.) 6,951. March 25th.

Forming Lead Peroxide on Plates of Electric Accumulators. J. Diamant. 6,954. March 25th.

Manufacture of Stranded Electrical Conductors. E. A. Claremont and J. Stratton. 6,998. March 26th.

Devices for Suspending Overhead Electric Conductors. E. A. Carolan. (The General Electric Co., United States.) 7,195. March 27th.

Selective Transmitting Systems. E. A. Carolan. (The General Electric Co., United States.) 7,137. March 27th.

Alternating Electric Current Motors. E. A. Carolan. (The General Electric Co., United States.) 7,141. March 27th.

Electric Metering Systems. E. A. Carolan. (The General Electric Co., United States.) 7,142. March 27th.

Electric Collector Shoes or Slippers for the Insulated Third Rail of Electric Railways and Tramways. E. J. Chambers. 7,235. March 30th.

Standards and Supporting Devices of the Trolley or Collecting Poles of Electric Vehicles. W. H. Turner and W. H. Isherwood. 7,387. March 30th.

Two-way Electric Switch. E. W. Lewis. 7,415. March 31st.

High-tension Electric Circuit Breakers. E. A. Carolan. (The General Electric Co., United States.) 7,452. March 31st.

Connection Boxes for Electric Conductors. E. A. Carolan. (The General Electric Co., United States.) 7,455. March 31st.

Supports and Casings for Electric Conductors. E. A. Carolan. (The General Electric Co., United States.) 7,456. March 31st.

Electric Arc Lamps. E. A. Carolan. (The General Electric Co., United States.) 7,459. March 31st.

Electric Circuit Protecting Devices. E. A. Carolan. (The General Electric Co., United States.) 7,461. March 31st.

Ceiling Roses, Cut-outs, and the like for Electric Lighting Purposes. R. T. Crocott. 7,527. April 1st.

Fusible Electric Cut-outs. J. Hetherington and the British Electric Transformer Co. (1903), Ltd. 7,568. April 1st.

Electro-magnetic Mechanism for Producing Reciprocatory Motion. J. T. Mould. 7,590. April 1st.

Continuous Current Arc Lamps. W. E. Evans. (Allgemeine Electricitäts Gesellschaft, Germany.) 7,608. April 1st.

Telephonic Systems. R. P. Wilson. 7,676. April 2nd.

Carbon Electrodes for Arc Lamps. A. Edelmann. 7,783. April 3rd.

Safety Electric Fuses. G. W. Partridge. 7,790. April 3rd.

Electric Switch Apparatus. C. Pieper. 7,827. April 4th.

Prepayment Electric Meters. The British Westinghouse Electric and Manufacturing Co., Ltd. (G. G. Tilden, United States.) 7,899. April 6th.

"ELECTRICAL REVIEW" LIST O

Place.	Supply Authority.	Year of opening	Engineer.	Pressure of supply, volts.	Frequency and Phase.	Boilers and Auxiliaries.	Engines.
PROVINCIAL.							
1 ABERDEEN	Corporation	1894	J. Alex. Bell	220 & 440	Direct	8 B. & W., 2 suphtrs. (Cotton St.).	6 Willans, 1 Belliss
						6 B. & W. (2 more on order), suphtrs., ch. g. stokers, cond. (Dee Village).	7 Willans
2 ABERYSTWYTH	A. & Chiswick Elec. Supply Corpn.	1895	W. L. Knight	100 & 220	100~, 1-ph., & direct	3 Paxman Economic	4 Browett-Lindley, 2 Peac
3 ACCRINGTON	Corporation	1900	H. Gray	230 & 460	Direct	3 Lanc., econ., cond.; 6-cell Horsfall destructor.	3 Willans, 2 Browett-Lind
4 ALDERLEY EDGE	A. & Wilmslow Electric Supply Co.	1899	C. W. Bentley	210	Direct	2 loco. (Paxman)	2 Belliss
5 ALDERSHOT TOWN	Urban District Council	1902	F. Garside	210 & 420	Direct	3 B. & W., econ., cond.	4 Willans
6 ALLOA	Corporation	1902	J. W. Napin	220 & 440	Direct	Supply in bulk	from the Bri
7 ALNWICK	Northern Counties Elec. Supply Co.	1902	C. S. Vesey Brown & C. W. Fairweather	230 & 460	Direct	2 B. & W., stokers and econ.	2 Ruston Proctor
8 ALTRINCHAM	A. Electric Supply Co.	1895	H. C. Caldwell	100	80~, 1-ph.	6 Lanc. (4 Meldrum furn., 2 with stokers), cond., econ.	5 Browett-Lindley
9 ASHTON-U-LYNE	Corporation	1899	N. Appelbee	240 & 480	Direct	4 Lanc., 2 tubular, econ., cond., destr.	3 Browett-Lindley, 2 Bellis
10 ASTON MANOR	Corporation	1903	T. J. Ballard	230	Direct	6 B. & W., suphtrs.; Vicars stokers, econ., Hughes-Stirling destructor	3 Ferranti, 1 Reavell
11 ATHERTON	Urban District Council	1903	D. Williams	230 A.C., 500 D.C.	50~, 2-ph., & direct	Supply in bulk from	South Lancashire
12 AYR BURGH	Corporation	1896	Roland Marshall	100 & 200 A.C. 250 & 500 D.C.	60~, 1-ph. & direct	4 Lanc., 2 Stirling, 2 B. & W., Vicars and ch. g. stokers, 4 Meldrum destr. cells erecting	6 Belliss, 1 Marshall
13 BANBURY	B. & District Electric Supply Co.	1903	G. Charlton	230 & 460	Direct	2 B. & W.	3 Parsons turbines
14 BANGOR (WALES)	Corporation	1900	P. F. White	230 & 400	Direct	2 Hornsby water-tube, 2 Meldrum destr. cells	3 Willans
15 BARKING	Urban District Council	1899	A. H. Seabrook	230 & 460	Direct	4 B. & W., cond., clg. tr.	2 Sunderland Forge, 3 All
16 BARNES	Urban District Council	1901	C. S. Davidson	210 & 420	Direct	3 B. & W., cond., fd. htr.	4 Belliss
17 BARNSLEY	Corporation	1900	E. A. Barker	230 & 460	Direct	6 Lanc., stokers, cond., econ.	6 Willans
18 BARNSTAPLE	Corporation	1903	J. W. Hadfield	230	Direct	3 B. & W., suphtrs., econ., cond.	3 Reavell
19 BARROW-IN-FURNESS	Corporation	1899	H. R. Burnett	220 & 440	Direct	5 B. & W., econ., cond., Heenan & Froude destr. 4 cells	3 Universal, 4 Willans
20 BATH	Corporation	1890	F. Teague	100&200 A.C., 220 D.C.	100~, 1-ph., & direct	5 B. & W.	2 Pollitt & Wigzell, 4 Belliss
21 BATLEY	Corporation	1903	S. D. Jones	220 & 440	Direct	3 Lanc., Proctor stokers, econ., cond., clg. tr. and 1 Lanc. with 3-cell Horsfall destr.	3 Belliss
22 BECKENHAM	Urban District Council	1900	J. E. Sapper	200	50~, 1-ph.	4 B. & W., suphtrs., econ., detart., Horsfall dest. 3 cells	3 Belliss, 1 Browett-Lindley
23 BEDFORD	Corporation	1894	R. W. L. Phillips	105 & 210	60~, 1 ph.	7 B. & W., 2 Lanc., stokers, cond.	2 Belliss, 5 Allen
24 BELFAST	Corporation	1895	V.A.H. McCowen	220 & 440	Direct	6 Lanc., Victor Coates, 5 B. & W., stokers, econ., feed htrs., cond., clg. tr.	10 Belliss
25 BERWICK-UPON-TWEED	Urban Electric Supply Co.	1903	J. Hayward Home	240 & 480	Direct	2 Sugden water tube	2 Bellias
26 BEXHILL-ON-SEA	Corporation	1900	W. T. Le Feuvre	220 & 440	Direct	2 Hornsby, 1 B. & W., suphtrs., cond., clg. tr.	3 Allen
27 BEXLEY	Urban District Council	1903	C. Mittelhousen	200 A.C., 500 D.C., tr.	50~, 1-ph.	3 Lanc.	2 Browett-Lindley
28 BIRKDALE	B. District Electric Supply Co.	1902	H. Bentham	230 & 460	Direct	3 B. & W.	3 Browett-Lindley
29 BIRKENHEAD	Corporation	1896	W. Bates	230 & 460	Direct	4 Lanc., Vicars stokers, econ.; 2 B. & W., ch. g. stokers	7 Willans, 1 Scott & Mount
30 BIRMINGHAM	Corporation	1891	R. A. Chattock	220 & 440	Direct	20 Lanc., 4 B. & W.	13 Willans, 9 Belliss, 1 turbine
31 BLACKBURN	Corporation	1895	A. S. Giles	110, 220 A.C., 220 & 440 D.C.	50~, 1-ph., & direct	12 Lanc., stokers, econ., cond.	8 Willans, 7 Belliss
32 BLACKPOOL	Corporation	1893	Charles Furness	200 & 500	83~, 1-ph. & direct	5 Lanc., 2 Fraser, 5 B. & W.	5 Fowler, 1 Ferranti, 8 turbine
33 BLAENAU FESTINIOG	Yale Electric Power Co.	1900	T. P. O. Yale	220, 280 & 500	Direct		Water turbines
34 BLYTH & COWPEN	Northern Counties Elec. Supply Co.	1901	C. S. Vesey Brown, C. W. Fairweather	230 & 460	Direct	2 B. & W., econ.	2 Allen
35 BOLTON	Corporation	1894	A. A. Day	100 &200 A.C.; 230 & 460 D.C.	83~, 1-ph., & direct	11 Lanc., stokers, suphtrs., cond., clg. tr., econ.	6 Musgrave, 4 Hick Ha 1 Wood
36 BOOTLE	Corporation	1899	T. D. Clothier	220	Direct	8 Lanc., stokers, econ., cond.	6 Belliss, 2 Ferranti
37 BOURNEMOUTH AND POOLE	B. and Poole Electricity Supply Co.	1889	E. L. Ingram	100 &200 A.C.; 480 D.C.	100~, 1-ph., & direct	11 B. & W., cond., clg. tr.	8 Brush, 2 Browett-Lindley
38 BRADFORD	Corporation	1899	A. Blackman	230 & 460	Direct	4 Lanc., 6 marine, ind. draught, stokers, 10 water-tube, suphtrs., econ., cond., clg. tr.	18 Willans, 1 Marshall, Marchent & Morley.
39 BRAY	Urban District Council	1892	W. J. Sowter	100 & 200	60~, 1-ph.	1 loco., 2 Lanc., cond., econ.	1 Brush, 1 Easton - And Browett-Lindley, 1 Victor
40 BRECHIN	Angus Electric Lt. & Pr. Co.	1901	H. Dixon	240 & 480	Direct	2 B. & W., suphtr., feed htr.	2 Belliss
41 BRICHOUSE	Corporation	1898	A. Aspinall	110	Direct		3 Crossley gas
42 BRIGHTON	Corporation	1891	J. Christie	115, 230, & 460	Direct	6 Lanc., 10 B. & W.	18 Willans
43 BRISTOL	Corporation	1893	H. Faraday Proctor	105 &210 A.C.; 250 &500 D.C.	93~, 1-ph. & direct	12 Lanc., 10 B. & W., stokers, suphtrs., cond.	22 Willans, 3 Parsons turbin
44 BROMLEY (KENT)	Bromley (Kent) Elec. Lt. & Pr. Co.	1898	R. R. Barker	210	Direct	4 Paxman economic, cond.	6 Belliss
45 BROUGHTY FERRY	Corporation	1902	J. L. Turnbull	230 & 460	Direct	2 B. & W., suphtrs. cond.	2 Belliss
46 BUCKINGHAM	B. Electric Lt. & Pr. Supply Co.	1880	*	100	Direct	1 Cochrane vertical, 1 Marshall loco.	1 Brown & May, 1 Marshall
47 BURNLEY	Corporation	1893	R. Birkett	220 & 440	Direct	5 Lanc., stokers, econ.	3 Burnley Iron Works, 4 Bel
48 BURTON-ON-TRENT	Corporation	1894	P. J. Pringle	100 & 200	75~, 1-ph	6 Lanc., econ., cond.	3 Fowler; 1 Alley - Macle Willans (tr.)
49 BURY (LANCS.)	Corporation	1896	S. J. Watson	220, 440 & 500	Direct	5 Lanc., econ., cond.	6 Belliss
50 BURY ST. EDMUNDS	Corporation	1900	L. P. Greig	200 & 400	Direct	2 Lanc., detart., econ.	3 Belliss
51 BUXTON	Urban District Council	1900	W. J. Leaming	230	Direct	6 Hornsby w.t., cond.	6 Belliss
52 CAMBORNE, REDRUTH AND ILLOGAN	Urban Electric Supply Co.	1902	F. S. Hanning	240 & 480	Direct	2 Lanc.	4 Belliss
53 CAMBRIDGE	Cambridge Elec. Supply Co.	1892	H. B. Harvey	200	90~, 1-ph.	4 Lanc., econ.	7 Parsons turbines
54 CANTERBURY	Corporation	1899	C. A. Blascheck	220	Direct	4 Lanc., stokers, econ., cond.: 1 B. & W. with 2-cell Beaman & Deas destr.	4 Belliss
55 CARDIFF	Corporation	1894	Arthur Ellis	200, 400 & 500	40~, 1-ph. & direct	5 dryback, 3 B. & W., suphtrs., cond.	2 Paxman, 3 Belliss, 1 Ferra
56 CARLISLE	Corporation	1899	C. D. Burnet	230 & 460,	Direct	5 Lanc., stokers, econ., cond.	

PART I.

ST OF ELECTRICITY SUPPLY WO

Engines.	Generators.	Total Capacity in KW.	Max. load recorded in KW.	Battery Capacity and Output.	Mains.	Total capital expended.	Private lightin eqvt. 8 c lamps
Willans, 1 Belliss	3 E.C.C., 2 Holmes, 1 Crompton, 1 Mather & Platt	760	1,682	E.P.S., 20 KW. for 10 hrs. E.P.S., 90 KW. for 10 hrs.	Bare copper, bit. paper and jute in Crompton Davies casing, iron pipes, wdn. troughing, solid	£194,079	90,5
Willans	1 J. Lundell, 2 Mavor & Coulson, 1 Westinghouse, 1 Peebles, 2 Holmes	1,680					
Browett-Lindley, 2 Peache	2 Johnson & Phillips, A. C., 2 J. & P. D. C., 2 Brush arc.	240	140		B.I. & H., armd. and lead covd. conc.		9,7
Willans, 2 Browett-Lindley	3 J. & P., 2 Lancs. Dynamo Co.	535	388	Chloride, 160 KW. max. dis.	Glover and B.I. & H., single core ppr.; feeders solid, dist. armd. direct	£44,500	15,6
Belliss	2 Edison & Swan	92	57	D-P., 240 KW. hrs.	Callender, triple conc. fdrs., 3-core dist.; both armd. and lead covd.	£23,000	7,3
Willans	4 Parker	440	156	D-P., max. dis. 20 K.W.	Callender feeders and distributors, single, laid solid	£34,500	7,3
from the British	Electric Plant Co., Ltd.		58		Callender, fdrs. 3-core, dist. single, v. bit., solid	£9,500	2,4
Ruston Proctor	2 Crompton	150		Chloride 250 amp.-hrs.	Callender, single, solid, in wood	£12,000	
Browett-Lindley	5 Edison & Swan	600	399		Fdrs. v.r. conc., dist. armd. Diatrine and ppr.	£59,192	38
Browett-Lindley, 2 Belliss	3 Jackson (Sayers), 3 Siemens	1,260	700		Conc. paper and bitumen	£50,000	
Ferranti, 1 Reavell	2 Dick Kerr, 1 Westinghouse, 1 G.E.C.	1,300			B.I. & H., solid		8,4
uth Lancashire Electric	Traction & Power Co., Ltd.				Callender, conc., ppr. ins. bit. solid in wood troughs	£10,000	2
Belliss, 1 Marshall	4 Siemens A. C.; 1 Siemens, 2 Peebles D. C.	1,125	540	E. P. S., 30 KW. for 7 hrs. max. disch. 100 K.W.	Callender, conc. armd., A.C.; bit. solid, D.C., in wood	£83,510	
Parsons turbines	3 Parsons	360	78	Hart, max. dis. 14 K.W.	Callender, fdrs. twin conc. v. bit., dist. 3-core, all laid solid		
Willans	2 Fowler, 1 J. P. Hall	290	175	Chloride, 35 KW. for 6 hrs., and Hart	B.I. & H. triple conc., ppr., lead covd., armd.	£23,690	
Sunderland Forge, 3 Allen	2 S. Forge, 2 Thames Ironworks, 1 Siemens	610	400		Callender, fdrs., conc. in c.w. casing, dist. Callender bit. single and Siemens 3-core	£50,000	1
Belliss	4 Siemens	470	155	E. P. S., 25 KW. for 7 hrs., max. dis. 60 K.W.	Callender, fdrs. tr. conc., dist. 3-core, jute, lead covd.; armd. direct, unarmd. in Sykes conduit	£39,000	1
Willans	4 J. & P., 2 Peebles	1,200	689	Pritchetts & Gold, lg.: E.P. S. tr.: max. dis. 150 KW.	B. I. & H. Co., ppr. lead covd., solid. also dist. armd. 3-core direct.	£60,536	3
Reavell	3 Taunton	375	125	A. B. P., 200 KW. max. dis.	St. Helens Cable Co., Dialite, laid solid in wood.	£27,000	
Universal, 4 Willans	3 Brush, 2 Peebles, 2 Dick Kerr	1,025	523 lg., 270 tr.	Tudor & chloride; lg. 198 KW.; tr. 168 KW., max. disch.	B.I & H., and Anchor, ppr. conc., lead covd.: dist. tr. conc.	£78,575	3
Pollitt & Wigzell, 4 Brush, 4 Belliss	2 E. C. C., 4 Mordey (rope-driven) & 4 Dick Kerr	2,200	829		Callender, v. bit. single, solid, and B.I. & H. tr. conc.; Callender dist. lead covd. and armd conc.	£137,226	4
Belliss	3 Fowler	450	350	Baker, Bauer; max. dis. 100 KW.	Callender, 3-core ppr. and v. bit., in Howard troughing; dist. do., laid solid	£28,609	
Belliss, 1 Browett-Lindley	3 Fowler, 1 Johnson & Phillips	550	290		B.I. & H., conc., ppr., lead covd.	£67,000	
Belliss, 5 Allen	1 Johnson & Phillips, 2 Siemens, 3 Fynn	860	560		V. r. in ducts, and ppr. B.I. & H, 2 and 3-core	£94,204	
Belliss	6 Parker, 5 M. & P., 1 J. & P.	3,000 180	2,190	E. P. S., max. dis. 400 KW.	Callender, single vule. bit., solid, and drawn into c.i. and e'ware pipes	£220,000	1
Belliss	2 Crompton		52	D.P., max. dis. 96 KW.	Callender, v. bit. lead covd. & armd.; fdrs. tr. conc. & single; dist. 3-core	£20,000	
Allen	3 Allen	350	250	Chloride, 50 KW. for 5 hrs.	B.I. & H., fdrs. triple conc.; dist. 3-core; ppr., lead covd. and armd.	£33,000	
Browett-Lindley	Dick Kerr, 2 A.C., 2 D.C. (traction)	A.C. 300 D.C. 300		Hart, max. dis. 200 KW.	Anchor Cable Co., lead covd., conc. paper and v. bit. for tr., triple conc. paper for ltg.	£15,800	
Browett-Lindley	3 Bruce Peebles	300	160	Accumulatoren A.G., max. dis. 75 KW.	Callender, fdrs. conc. (single neutral), dist. 3-core	£28,504	
Villans, 1 Scott & Mountain	3 Crompton, 2 Siemens, 2 Mavor & Coulson, 1 Scott & Mountain	1,050	566	E. P. S., 460 KW., max. dis.	Callender, fibre ins., lead covd., fdrs., laid solid, dist. armd.	£101,152	
Willans, 9 Belliss, 1 Parsons urbine	4 M. & P., 13 Crompton, 5 E. C. C. 1 Parsons	5,260	4,060	E. P. S. & Tudor, max. dis., 144 KW.	Callender, v. bit., solid	£614,988	1
Villans, 7 Belliss	1 M. & P., 7 Siemens, 3 Mavor & Coulson, 3 Dick Kerr	4,628	1,778	E. P. S., 200 KW. max. dis.	Siemens, Glover, and B.I. & H. v. r. andppr. fdrs.; ppr. and v. r. dist., various makers	£220,000	
Fowler, 1 Ferranti, 8 Parsons urbine	8 Parsons, 3 Fowler, 2 E. C. C., 1 Ferranti	3,050	1,730	Hart, 175 KW., max. dis.	H.p. fdrs. twin, l.p. conc. and single, ppr., solid, B.I. & H. and St. Helens	£173,000	
ter turbines	Sandycroft Foundry			Tudor	Overhead, bare	£20,000	
llen	2 Crompton	400		Chloride, 40 KW. for 5 hrs.	Callender, single cables laid solid	£25,000	
Musgrave, 4 Hick Hargreaves, Wood	1 Dick Kerr, 4 Mather & Platt D.C., 4 Ferranti, 1 Mordey A.C.	4,400	2,420		B.I. & H., and Glover, h.p. conc. v.r. and ppr., ld. covd. in pipes or armd.; dist., single, ld. covd., armd.	£241,801	
elliss, 2 Ferranti	5 Parker, 1 E. C. C., 2 Bruce Peebles	2,050	814	Chloride, max. dis. 500 KW.	Callender, solid	£93,802	
rush, 2 Browett-Lindley	2 Ferranti, 6 Brush A.C., 2 Brush D.C.	3,960	1,485	Chloride, 206 KW., max. dis.	Fdrs. conc., paper, B.I. & H. Siemens, Glover, Callender; dist. tr. conc., Callender, Glover	£286,890	
Willans, 1 Marshall, 2 Cole, Marchent & Morley.	15 Siemens, 2 E. C. C., 2 Peebles, 2 Westinghouse.	6,380	4,977	E. P. S., 400 KW. for 6 hrs	Ppr. lead covd., armd., also solid for fdrs.	£429,768	
Brush, 1 Easton - Anderson, 1 rowett-Lindley, 1 Victor turbine	1 Witting, 1 International, 1 Easton-Anderson, 1 J. & P.	320	92		B.I. & H. & Callender, ppr., lead covd. conc. direct	£10,500	
elliss	2 Parker	132	91	D. P., 300 amp.-hrs.	Callender, fdrs. conc., dist. 3-core	£20,000	
ossley gas	3 Brook	40	40	Chloride, 28 KW. max. dis.	Glover and St. Helens, insulated, overhead	£2,258	
Villans	2 Goolden, 2 Siemens, 3 Crompton, 3 Peebles, 8 E. C. C.	6,135	4,534	Tudor, 400 amp.-hrs., lighting. E. P. S., 1,200 amp-hrs., tr.	Triple conc. and single, armd. direct, and solid.	£339,602	
Villans, 3 Parsons turbine	16 Siemens A. & C., 1 Ferranti, 4 Dick Kerr, 2 Parsons, 2 Westinghouse	6,546	3,444	E. P. S., max. dis., 70 KW.	Siemens & B.I. & H., conc. armd. jute and ppr. fdrs.; tr. conc. jute and paper dist.	£508,585	
lliss	6 Parker	800	380	Pritchetts & Gold, 40 KW. for 10 hrs.	Callender, fdrs. triple conc., dist. 3-core	£81,725	
lliss	2 Parker	90	47	E. P. S., 450 amp-hrs.	Callender, single, laid solid in wood	£13,000	
rown & May, 1 Marshall	1 Greenwood & Batley, 2 Elwell-Parker, 1 Goolden	60		E. P. S., 3 sets, 9 KW. for 10 hrs.	Overhead		
urnley Iron Works, 4 Belliss	3 Parker, 2 E.C.C., 2 Dick Kerr	1,500	1,247	Tudor, ltg. 66 KW., tr. 250 KW. max. dis.	Fdrs. armd. and solid, dist. solid various makers	£85,604	
owler; 1 Alley - Maclellan; 3 illans (tr.)	3 Fowler, 1 Brown-Boveri; 3 B. T. H. (tr.)	810	370		B.I. & H. h.p., conc.; Silvertown v. r. single and B.I. & H., conc. l.p., part solid, part iron pipes for both	£60,000	
lliss	6 Siemens	1,310	487	E. P. S., lg. 132 KW., tr. 225 KW., for 1 hr.	V.r. and v. bit., lead covd., in c.i. and stoneware pipes and solid	£71,000	
lliss	3 Fowler	232	165.5	E. P. S., max. dis. 200 KW.	Callender, triple conc. and 3-core armd.	£27,748	
lliss	6 M. & P., 2 Sunderland Forge, 1 E. C. C.	588	202.5	Tudor, 250 amp.-hrs.	Callender, conc., jute, lead covd. and armd., laid direct	£41,500	
lliss	5 Parker	480	250	Chloride, max. dis. 200 KW.	Callender, laid solid		
rsons turbines	7 Parsons	1,500	574		Paper ins., fdrs. twin, dist. 3-core	£86,282	
lliss	6 Silvertown, 2 Johnson & Phillips	600	389	Chloride	Western Elec. triple conc., lead covd. and armd., direct, also Siemens & Henley	£52,348	
xman, 3 Belliss, 1 Ferranti	5 Siemens, 1 Ferrant	1,560	918 A.C. 795 D.C.	Tudor, max. dis. 500 KW.	V. r. conc., ppr., armd., Siemens and B.I. & H.	£189,134	

58	CARLISLE	Corporation	1899	C. D. Burnet ..	500 230 & 460,	& direct Direct ..	5 Lanc., stokers, econ., cond.							2 Paxman, 3	llis, 1 Fer

PART I.

LIST OF ELECTRICITY SUPPLY WORKS OF T

	Engines.	Generators.	Total Capacity in KW.	Max. load recorded in KW.	Battery Capacity and Output.	Mains.	Total capital expended.	Private lighting, eqvt. 8 c.p. lamps.	Public lighting.	No. and H.P. of private motors.	No. and H.P. of traction motors.	Total connections of all kinds, eqvt. 8 c.p. lamps.
.. ..	6 Willans, 1 Belliss	3 E.C.C., 2 Holmes, 1 Crompton, 1 Mather & Platt	760	1,682	E.P.S., 20 KW. for 10 hrs. E.P.S., 90 KW. for 10 hrs.	Bare copper, bit. paper and jute in Crompton Davies casing, iron pipes, wdn. troughing, solid	£194,079	90,911	281 arc ..	302=1160 H.P.	114=2850 H.P.	126,527
ntrs., ch. g.	7 Willans	1 J. Lundell, 2 Mavor & Coulson, 1 Westinghouse, 1 Peebles, 2 Holmes	1,680									
.. ..	4 Browett-Lindley, 2 Peache ..	2 Johnson & Phillips, A. C., 2 J. & P. D. C., 2 Brush arc.	240	140	.. ..	B.I. & H., armd. and lead covd. conc.	..	9,795	29 arc, 1 inc.	..	..	10,250
destructor..	3 Willans, 2 Browett-Lindley ..	3 J. & P., 2 Lancs. Dynamo Co. ..	535	238	Chloride, 160 KW. max. dis...	Glover and B.I. & H., single core ppr.; feeders solid, dist. armd. direct	£44,500	15,622	9 arc, 57 inc.	29=175 H.P.	..	21,635
.. ..	2 Belliss	2 Edison & Swan	92	57	D-P., 240 KW. hrs.	Callender, triple conc. fdrs., 3-core dist.; both armd. and lead covd.	£23,000	7,707	..	1=2 H.P. ..	..	7,707
.. ..	4 Willans	4 Parker	440	156	D-P., max. dis. 20 K.W. ..	Callender feeders and distributors, single, laid solid ..	£24,500	7,684	16 arc, 18 inc., 3 Nernst	9=23 H.P. ..	..	8,693
built	from the British	Electric Plant Co., Ltd.	..	58	.. ..	Callender, fdrs. 3-core, dist. single. v. bit., solid ..	£9,500	2,800	20 arc ..	7=9 H.P. ..	..	3,325
.. ..	2 Ruston Proctor	2 Crompton	150	..	Chloride 250 amp.-hrs. ..	Callender, single, solid, in wood	£12,000	..	..	..	..	..
kers, cond.,	5 Browett-Lindley	5 Edison & Swan	600	399	.. ..	Fdrs. v.r. conc., dist. armd. Diatrine and ppr.	£59,192	38,676	..	2=15 H.P.. ..	..	39 050
.. ..	3 Browett-Lindley, 2 Belliss	3 Jackson (Sayers), 3 Siemens ..	1,260	700	.. ..	Conc. paper and bitumen	£50,000	..	72 arc, 144 inc.	..	600 H.P. ..	20,000
kers, econ.,	3 Ferranti, 1 Reavell	2 Dick Kerr, 1 Westinghouse, 1 G.E.C.	1,300	..	.. ..	B.I. & H., solid	..	8,840	..	16=106 H.P.	..	11,498
lk from	South Lancashire Electric	Traction & Power Co., Ltd.	..	..	.. ..	Callender, conc., ppr. ins. bit. solid in wood troughs ..	£10,000	2,300	..	12=194 H.P.	..	6,956
and ch. g. rting	6 Belliss, 1 Marshall	4 Siemens A. C.: 1 Siemens, 2 Peebles D. C.	1,125	540	E. P. S., 30 KW. for 7 hrs. max. disch. 100 K.W.	Callender, conc. armd., A.C.; bit. solid, D.C., in wood	£83,510	..	121 arc, 155 inc., 10 N.	21=92 H.P.	32=800 H.P.	24,080
.. ..	3 Parsons turbines	3 Parsons	369	78	Hart, max. dis. 14 K.W. ..	Callender, fdrs. twin conc. v. bit., dist. 3-core, all laid solid	..	4,713	2 arc, 4 inc., 3 Nernst	2=7½ H.P. ..	..	5,000
te cells ..	3 Willans	2 Fowler, 1 J. P. Hall	290	175	Chloride, 35 KW. for 6 hrs., and Hart	B.I. & H. triple conc., ppr., lead covd., armd.	£23,690	8,340	..	6=17½ H.P.	..	8,778
.. ..	2 Sunderland Forge, 3 Allen ..	2 S. Forge, 2 Thames Ironworks, 1 Siemens	610	400	.. ..	Callender, fdrs. conc. in c.w. casing, dist. Callender bit. single and Siemens 3-core	£50,000	11,681	1815 eqv. 8 c.p.	325 H.P. ..	440 H P. ..	32,086
.. ..	4 Belliss	4 Siemens	470	155	E. P. S., 25 KW. for 7 hrs., max. dis. 60 K.W.	Callender, fdrs. tr. conc., dist. 3-core, jute, lead covd.; armd. direct, unarmd. in Sykes conduit	£39,000	14,310	814 eqv. 8 c.p. Nernst	12½ H.P. ..	..	15,424
.. ..	6 Willans	4 J. & P., 2 Peebles	1,200	689	Pritchetts & Gold, lg.: E.P. S. tr.: max. dis. 150 KW.	B. I. & H. Co., ppr. lead covd., solid. also dist. armd. 3-core direct.	£60,536	31,171	46 arc, 86 inc., 12 Nernst	82	..	40,176
.. ..	3 Reavell	3 Taunton	375	125	A. B. P., 200 KW. max. dis. ..	St. Helens Cable Co., Dialite, laid solid in wood. ..	£27,000	6,050	14 arc, 84 inc.	10=15 H.P.	..	6,830
ndle destr.	3 Universal, 4 Willans	3 Brush, 2 Peebles, 2 Dick Kerr ..	1,025	523 lg., 370 tr.	Tudor & chloride; lg. 198 KW.; tr. 168 KW., max. disch.	B.I & H., and Anchor, ppr. conc., lead covd.; dist. tr. conc.	£78,575	34,615	48 arc, 93 inc. 126 Nernst	73=360 H.P.	24=600 H.P.	44,882
.. ..	2 Pollitt & Wigzell, 4 Brush, 4 Belliss	2 E. C. C., 4 Mordey (rope-driven) & 4 Dick Kerr	2,200	829	.. ..	Callender, v. bit. single, solid, and B.I. & H. tr. conc.; Callender dist. lead covd. and armd conc.	£137,226	49,231	182 arc, 6 inc., 2 Nernst	15=28¼ H.P.	..	54,387
dle, tr. and	3 Belliss	3 Fowler..	450	350	Baker, Bauer; max. dis. 100 KW.	Callender, 3-core ppr. and v. bit., in Howard troughing; dist. do., laid solid	£28,609	2,223	45 arc, 100 inc.	17=104½ H.P.	20=748 H.P.	25,735
rd-fall dest.	3 Belliss, 1 Browett-Lindley ..	3 Fowler, 1 Johnson & Phillips ..	550	290	.. ..	B.I. & H., conc., ppr., lead covd.	£67,000	20,447	17 arc, 32 inc.	5=13 H.P. ..	..	21,092
.. ..	2 Belliss, 5 Allen	1 Johnson & Phillips, 2 Siemens, 3 Fynn	880	560	.. ..	V. r. in ducts, and ppr. B.I. & H, 2 and 3-core.. ..	£94,204	41,692	3 arc., 564 inc	22=92 H.P.	..	45,165
kers, econ.,	10 Belliss	6 Parker, 5 M. & P., 1 J. & P. ..	3,000	2,190	E. P. S., max. dis. 400 KW. ..	Callender, single vule. bit., solid, and drawn into c.i. and e'ware pipes	£230,000	111,872	4 arc, 56 inc.	2,060 H.P. ..	..	171,845
.. ..	2 Belliss..	2 Crompton	180	52	D.P., max. dis. 96 KW. ..	Callender, v. bit. lead covd. & armd.; fdrs. tr. conc. & single; dist. 3-core	£20,000	3,937	17 arc, 34 inc.	8=55 H.P...	..	5,714
l, cdg. tr.,	3 Allen	3 Allen	350	250	Chloride, 50 KW. for 5 hrs. ..	B.I. & H., fdrs. triple conc.; dist. 3-core; ppr., lead covd. and armd.	£33,000	11,500	41 arc, 332 inc.	9=26 H.P...	..	13,480
.. ..	2 Browett-Lindley	Dick Kerr, 2 A.C., 2 D.C. (traction)	A.C. 300 D.C. 300	..	Hart, max. dis. 200 KW. ..	Anchor Cable Co., lead covd., conc. paper and v. bit. for tr., triple conc. paper for ltg.	£15,800	..	150 inc., 110 Nernst	..	24=600 H.P.	..
.. ..	3 Browett-Lindley	3 Bruce Peebles	300	160	Accumulatoren A.G., max. dis. 75 KW.	Callender, fdrs. conc. (single neutral), dist. 3-core ..	£28,504	8,619	..	..	105 H.P. ..	11,578
& W., ch.	7 Willans, 1 Scott & Mountain ..	3 Crompton, 2 Siemens, 2 Mavor & Coulson, 1 Scott & Mountain	1,050	566	E. P. S., 460 KW., max. dis...	Callender, fibre ins., lead covd., fdrs., laid solid, dist. armd.	£101,152	44,261	58 arc ..	42=130 H.P.	..	50,353
.. ..	13 Willans, 9 Belliss, 1 Parsons turbine	4 M. & P., 13 Crompton, 5 E. C. C. 1 Parsons	5,260	4,060	E. P. S. & Tudor, max. dis., 144 KW.	Callender, v. bit., solid	£614,988	187,238	..	480=1,395 H.P.	..	226,298
.. ..	8 Willans, 7 Belliss	1 M. & P., 7 Siemens, 3 Mavor & Coulson, 3 Dick Kerr	4,628	1,778	E. P. S., 200 KW. max. dis...	Siemens, Glover, and B.I. & H. v. r. andppr. fdrs.; ppr. and v. r. dist., various makers	£220,000	79,405	4,230 eq. 8 c.p.	820 H.P. ..	100.8 H.P. ..	138,485
.. ..	5 Fowler, 1 Ferranti, 8 Parsons turbine	8 Parsons, 3 Fowler, 2 E. C. C., 1 Ferranti	3,050	1,730	Hart, 175 KW., max. dis. ..	H.p. fdrs. twin, l.p. conc. and single, ppr., solid, B.I. & H. and St. Helens	£173,000	51,680	265 arc, 290 inc.	28=128 H.P.	122=2,214 H.P.	106,052
.. ..	Water turbines..	Sandycroft Foundry	..	..	Tudor	Overhead, bare..	£20,000	5,435	..	..	400 H.P. ..	16,900
.. ..	2 Allen	2 Crompton	400	..	Chloride, 40 KW. for 5 hrs. ..	Callender, single cables laid solid	£25,000	..	..	..	..	..
tr., econ..	6 Musgrave, 4 Hick Hargreaves, 1 Wood	1 Dick Kerr, 4 Mather & Platt D.C., 4 Ferranti, 1 Mordey A.C.	4,400	2,420	.. ..	B.I. & H., and Glover, h.p. conc. v.r. and ppr., ld. covd. in pipes or armd.; dist., single, ld. covd., armd.	£241,801	108,910	8 arc ..	272=2,092 H.P.	..	160,944 (lg.)
.. ..	6 Belliss, 2 Ferranti	5 Parker, 1 E. C. C., 2 Bruce Peebles	2,050	814	Chloride, max. dis. 500 KW...	Callender, solid	£93,802	29,587	166 arc, 1,451 equiv. 8 c.p.	719 H.P. ..	325 KW. ..	61,850
.. ..	8 Brush, 2 Browett-Lindley ..	2 Ferranti, 6 Brush A.C., 2 Brush D.C.	3,960	1,485	Chloride, 206 KW., max. dis...	Fdrs. conc., paper, B.I. & H. Siemens, Glover, Callender; dist. tr. conc., Callender, Glover	£286,890	93,320	110 Nernst..	150 H.P. ..	34=850 H.P.	124,568
s, 10 water-	18 Willans, 1 Marshall, 2 Cole, Marchent & Morley.	15 Siemens, 2 E. C. C., 2 Peebles, 2 Westinghouse.	6,380	4,977	E. P. S., 400 KW. for 6 hrs ..	Ppr. lead covd., armd., also solid for fdrs.	£429,768	239,509	51 arc ..	913=4,398 H.P.	..	..
.. ..	1 Brush, 1 Easton - Anderson, 1 Browett-Lindley, 1 Victor turbine	1 Witting, 1 International, 1 Easton-Anderson, 1 J. & P.	320	92	.. ..	B.I. & H. & Callender, ppr., lead covd. conc. direct ..	£10,500	5,021	30 arc, 200 inc.	..	..	6,750
.. ..	2 Belliss	2 Parker..	132	91	D. P., 300 amp.-hrs.	Callender, fdrs. conc., dist. 3-core	£20,000	6,295	101 inc. ..	6=27 H.P...	..	7,172
.. ..	3 Crossley gas	3 Brook	40	40	Chloride, 28 KW. max. dis. ..	Glover and St. Helens, insulated, overhead	£2,258	2,500	..	20	..	3,000
.. ..	18 Willans	2 Goolden, 2 Siemens, 3 Crompton, 3 Peebles, 8 E. C. C.	6,135	4,584	Tudor, 400 amp.-hrs., lighting. E. P. S., 1,200 amp-hrs., tr.	Triple conc. and single, armd. direct, and solid.. ..	£339,602	196,000	367 arc, 2,500 inc.	135=600 H.P.	80=2,400 H.P.	281,500
s., cond., ..	22 Willans, 3 Parsons turbine ..	16 Siemens A. & C., 1 Ferranti, 4 Dick Kerr, 2 Parsons, 2 Westinghouse	6,546	3,444	E. P. S., max. dis., 70 KW. ..	Siemens & B.I. & H., conc. armd. jute and ppr. fdrs.; tr. conc. jute and paper dist.	£508,585	168,486	674 arc, 8 inc.	460=2,306 H.P.	..	234,071
.. ..	6 Belliss	6 Parker..	800	380	Pritchetts & Gold, 40 KW. for 10 hrs.	Callender, fdrs. triple conc., dist. 3-core	£81,725	27,414	..	20=155 H.P.	..	31,280
.. ..	2 Belliss	2 Parker	90	47	E. P. S., 450 amp-hrs. ..	Callender, single, laid solid in wood	£13,000	5,171	12 arc, 36 inc.	5=20 H.P...	..	..
.. ..	1 Brown & May, 1 Marshall ..	1 Greenwood & Batley, 2 Elwell-Parker, 1 Goolden	60	..	E. P. S., 3 sets, 9 KW. for 10 hrs.	Overhead	..	1,300	10 inc ..	..	..	..
.. ..	3 Burnley Iron Works, 4 Belliss ..	3 Parker, 2 E.C.C., 2 Dick Kerr ..	1,500	1,247	Tudor, ltg. 66 KW., tr. 250 KW. max. dis.	Fdrs. armd. and solid, dist. solid various makers ..	£85,604	37,223	110 eq. 8 c.p.	181 H.P. ..	46=3,460 H.P.	122,207
.. ..	3 Fowler; 1 Alley - Maclellan; 3 Willans (tr.)	3 Fowler, 1 Brown-Boveri; 3 B. T. H. (tr.)	810	370	.. ..	B.I. & H. h.p., conc.; Silvertown v. r. single and B.I. & H., conc. l.p., part solid, part iron pipes for both	£60,000	23,703	1 arc ..	17=115 H.P.	40=1,000 H.P.	53,800
.. ..	6 Belliss..	6 Siemens	1,310	487	E. P. S., lg. 132 KW., tr. 225 KW., for 1 hr.	V.r. and v. bit., lead covd., in c.i. and stoneware pipes and solid	£71,000	..	..	..	..	38,071
.. ..	3 Belliss..	3 Fowler	232	165.5	E. P. S., max. dis. 200 KW. ..	Callender, triple conc. and 3-core armd.	£27,748	6,104	14 arc, 405 inc.	13=75 H.P.	Water works 50 H.P.	10,401
.. ..	6 Belliss	6 M. & P., 2 Sunderland Forge, 1 E. C. C.	588	202.5	Tudor, 250 amp.-hrs.	Callender, conc., jute, lead covd. and armd., laid direct	£41,550	14,905	..	16=40 H.P.	..	16,000
.. ..	4 Belliss..	5 Parker	490	250	Chloride, max. dis. 200 KW. ..	Callender, laid solid	..	5,121	2 arc, 180 inc.	23=200 H.P.	20=500 H.P.	25,156
.. ..	7 Parsons turbines	7 Parsons	1,500	574	.. ..	Paper ins., fdrs. twin, dist. 3-core	£86,282	43,913	1 arc ..	10=32 H.P.	..	44,038
B. & W. with	4 Belliss..	6 Silvertown, 2 Johnson & Phillips	600	339	Chloride..	Western Elec. triple conc., lead covd. and armd., direct, also Siemens & Henley	£52,248	18,765	12 arc, 440 inc. 19 Nernst	31=66 H.P.	..	21,995
d.	2 Paxman, 3 Belliss, 1 Ferranti ..	5 Siemens, 1 Ferrant	1,560	918 A.C. 795 D.C	Tudor, max. dis. 500 KW. ..	V. r. conc., ppr., armd., Siemens and B.I. & H. ..	£189,134	84,548	420 arc, 115 inc.	120=532 H.P	..	109,570
.. .. ..	6 Willans	2 Peebles, 4 Siemens	870	521	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd., armd. direct and	£51,550	19,900	48 arc, 20	50=112 H.P.	30=450 H.	34,800

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OF THE UNITED KINGDOM.

. and H.P. traction motors.	Total connections of all kinds, eqvt. 8 c.p. lamps.	Percentage increase during year.	Price charged per unit, pence.	System of charging.	Units sold during last complete year.	Pence Per Unit Sold. Av. price obtained.	Working costs.	Total costs.	Remarks.	
=2850 H.P.	126,527	24.7	Lg. 6. & 2½., pr. 3. & 1., tr. 1.64	Max. demand	2,577,308	2.81	.97	1.37	Lg. and tr.; one 720 KW. Willans-Westinghouse set on order for Dee village stn. Results are for year ending 31/7/03.	1
..	10,250	..	6.	Flat rate ..	..	..	..	..	Public lighting by contract	2
..	21,635	29	Lg. 4., pb. lg. 3., pr. 4. & 1.	Flat rate and scale	254,309	3.56	1.132	1.769	.. ..	3
..	7,707	20	Lg. 7. & 4., pr. 2½.	Max. demand & flat rate	51,940	6	..	..	.. ..	4
..	8,693	..	Lg. 6. & 4., pb. lg. 2½., pr. 3. & 2.	Max.demand	151,499	..	..	..	.. ..	5
..	3,325	..	Lg. 7. & 3., pr. 2.	Max. demand	58,500	..	..	..	.. ..	6
..	..	..	Lg. 5½. to 4., pr. 2½. to 1½.	Sliding scale	..	..	..	..	.. ..	7
..	39 050	..	Lg. 6., pr. 3. ..	Flat rate ..	..	..	..	..	.. ..	8
H.P. ..	20,000	..	Lg. 4., pr. 1½., pb. lg. 2½.	Flat rate ..	..	..	..	..	Lg. and r.	9
..	11,490	..	Lg. & pr. 6. & 1½..	Max. demand	..	..	..	..	* Destructor plant, 100 KW., auxiliary stand-by	10
..	6,956	..	Lg. 5., pr. & tr. 1½.	Flat rate ..	..	4.84	..	..	Lg. and tr. First year not yet completed	11
800 H.P.	24,080	50 (lg.)	Lg. 5., pr. & p. l. 2. tr. 1½. & 1.*	Flat rate ..	1,014,774	2.45	1.117	1.375	Lg. and tr. * First 200,000 units 1½d., above this 1d. Results for 1903.	12
..	5,000	..	Lg. 7. & 2½., pr. 4½. to 1½.	Max. demand	36,710	4.5	..	..	.. ..	
..	8,778	5.8	Lg. 5., pr. 2½. ..	Flat rate ..	110,273	4.91	2.70	3.64	Coke fuel, 12 - per ton. Electy. dept., overcharged for destructor steam	
H P. ..	32,086	93	Lg. 4½., pr. 3½. to 1½., tr. 2., are £20, inc. £4	Lg. flat rate, pr. sldg. sc.	487,734	3.4	1.56	1.9	Lg. & tr. *Call. & Siemens 3-core ld. cd. armd., ppr. ins., to outer area.	
..	15,424	70	Lg. 5., pr. 3. to 2., pb. lg. 2.	Flat rate & dis.	227,475	3.70	1.60	2.07	.. ..	
..	40,176	..	Lg. 7. & 2. or 4., pb. lg. 7. & 1½.,pr. & tr. 1½.	Max. dem. & flat rate	797,557	2.51	.788	1.088	Lg. and tr.	
..	6,830	50	Lg. 5., pr. 3. to 2.	Flat rate ..	76,824	6	1.9	2.3	.. ..	
600 H.P.	44,882	25.1 (lg.)	Lg. 6. & 3., pr. 3. & 1½., tr. 2. to 1½.	Max. demand	540,146	4.01	1.572	2.032	Lg. and tr. Pb. lg. arcs £17½ & £15, inc. £3 & £2½	
..	54,387	..	Lg. 5., pb. lg. arc £24, inc. £6, pr. 2½.	Flat rate & dis.	963,145	4.01	1.66	2.21	Supply by company 1890-7	
748 H.P.	25,735	..	Lg. 6. & 3., arc. £16, pr. 3. & 1., tr. 1½.	Max. demand	190,011	1.78	1.11	1.52	Lg. and tr.	
..	21,092	..	Lg. 5., pr. 2. & 1½., arc. £20	Flat rate ..	261,686	5½ private 3 public	2.25	2.78	*Free wiring 6d.	
..	45,165	..	Lg. 5½., pr. 2. ..	Flat rate ..	756,470	4.19	1.93	2.32	.. ..	
..	171,845	27	Lg. 6. & 1⅞. or 4., pr. 2½. and 1.	Max. demand and flat	2,255,579	2.93	.789	1.065	Station arranged for both lighting an traction	
..	5,714	29	Lg. 7. & 4. or 6. pr. 4. & 1½. or 2½.	Max. demand	..	4.6	1.1	2.8	Works started Sept., 1903. Arc £ p.a.	
..	13,480	..	7. & 3.	Max. demand	..	..	..	..	Further extension in hand ..	
600 H.P.	..	..	Lg. 6., pr. 6. and 2.	Flat rate and max. dem.	..	..	..	..	Works started October, 1903 ..	
H.P. ..	11,578	52	Lg. 7. & 2. or 5., pb. lg., pr. & tr. 2.	Max. demand, flat, & cont.	151,549	3.07	1.86	3.49	Lg. and tr.	
..	50,353	..	Lg. 6., 3., & 1½., or 5., pr. 2½. to 1½.,	Max. dem. or flat, pr. scale	661,171	3.79	1.12	1.58	Sep. plant for Corpn. Tramways. Pl lg. arc £18½ p.a.	
..	226,298	13.6	Lg. 6. & 4., pr. 3., 2. & 1½.	Flat rate with discount	4,367,164	3.64	1.24	1.74	Battery in sub-station only. Result to March 31, 1904.	
H.P. ..	138,485	29 (lg.)	Lg. 6. & 3., pb. lg. 2., pr. 2½. and 1½, tr. 1½.	Max. demand	2,895,181	2.37	.73	1.05	Lg. and tr.	
2,214 H.P.	106,052	..	Lg. 7. & 2., pb. lg. 3½. pr. 2½., tr. 2. to 1½.	Max. dem. flat rate and scale	2,169,463	4.1	1.52	1.76	Lg. and tr. Clg. trs., stokers, conden ing recently introduced	
H.P. ..	16,900	..	Lg. 4., pr. 4. to 1.	Flat rate & scale	..	..	..	..	.. ..	
..	..	..	Lg. 5½. to 4., pr. 2½. to 1½.	Flat rate & sliding scale	..	..	..	..	.. ..	
..	160,944 (lg.)	..	Lg. 6. & 3. or 4., pr. 2½., 1½. 1., tr. 1·25.	Max. dem. flat rate & scale	5,056,808	1.77	.581	.707	D.C. & A.C. lighting, D.C. power a traction.	
KW. ..	61,850	..	Lg. 5. & 3., pr. 2. to 1., tr. 1½. to 1.*	Max. demand	1,785,486	1.96	.72	.90	Lg. and tr. * Pb. lg., arc £21½..	
850 H.P.	124,568	21	Lg. 7. & 3., pr. 3...	Max. demand & flat	1,459,399	4.8	1.67	2.37	Total capacity and max. load inclu Christchurch	
..	..	..	Lg. 4½., pr. 2. & 1., tr. 1.	Flat rates ..	9,124,223	1.742	.524	.851	Lg. & tr.; lamps free. Motors & arc lps. on hire.	
..	6,750	..	Lg. 6. & 3½., pb. lg. £10 & £2	Max. demand & contract	135,000	4.4	3.4	4.18	.. ..	39
..	7,172	..	Lg. 6. & 4. or 5½., pr. 4. & 1½., or 2½.	Max. demand & flat rate	..	..	..	..	Harold Hale, Engineer-in-chief. 150 K.W. B.P. set, & 1 B.&W. boiler on order	40
..	3,000	..	Lg. 6., pr. 5. ..	Flat rate .	26,150	..	..	..	.. ..	41
400 H.P.	281,500	..	Lg. 7. & 1., tr. 1½...	Max. demand & flat rate	..	..	..	..	Lg. and tr.	42
..	234,071	16.5	Lg. 5., pr. 1½., pb. lg. arc £23	Flat rate with discount	4,299,504	3.34	1.11	1.58	General supply A.C., special supply D.C. in certain areas	43
..	31,280	..	Lg. 7. & 4., pr. 4. & 1.	Max. demand	419,000	4.7	1.45	2.02	Feeds Chislehurst through step-up transformers, at 2,000 volts	44
..	..	..	Lg. 6., pr. 4. ..	Flat rate ..	39,707	..	..	..	.. ..	45
..	..	..	8.	Flat rate ..	..	..	..	..	*Messrs. Gillies & Hornidge, engineers and proprietors	46
460 H.P.	122,207	..	Lg. 4., pb. lg 3., pr. 3. & 1., tr. 1½.	Flat rate & max. dem.	1,739,796	2.32	.764	1.020	Lg. and tr.	47
000 H.P.	53,800	12.2 (exc. tr.)	Lg. 6. & 3., pr. 3. & 1., or 2. to 1½.,	Max. demand & sldg. scale	678,020	3.12	1.14	1.52	Lg. & tr. Pb. lg. 3d., tr. 2d. to 1½d.	48
..	38,071	..	Lg. 6. & 3., or 4½., arc £17½, pr. 3. & 1., tr. 1½.	Max. demand & flat rate	672,911	2.8	..	..	Lg. and tr.	49
r works H.P.	10,401	21.9	Lg. 6., pr. 3. to 2½., arc £13, inc. 35s.	Flat rate with dis.	256,022	2.67	1.44	1.83	Corporation water works supplied at 1.75d. per unit	50
..	16,000	..	6., 4. & 3. or 7. & 3.	Sliding sc., or max. dem.	146,480	5.22	2.5	3.6	Max. load at end of summer; load through season heavier than in winter	51
00 H.P.	25,156	117	Lg. 7. & 4., pr. 4. & 1., tr. 1½.	Max. demand	363,984	2.3	.96	1.24	Lg. and tr.	52
..	44,038	8.7	Lg. 7., pb. lg. 3., pr. 3½.	Flat rate and contract	471,510	5.88	1.47	2.33	Data to Dec. 31st, 1903	53
..	21,995	14.6	Lg. 7. & 3. or 6. arc £25, inc. £3½, pr. 3 to 1½	Max. demand or flat rate	401,578	4.06	1.26	1.84	.. ..	54
..	109,570	31	Lg. 7. & 2. or 4½., pr. 4. & 1., pb. lg. 1½.	Max. dem., flat & prept.	2,385,472	2.95	1.2	1.5	Centre of town & docks, sup. by D.C. from tramway dept.	55
50 H.	34,800	25.9 (lg.)	Lg. 5. to 4., pr. 2., tr. 2. to 1½.	Sliding scales & flat rate	660,962	..	1.65	2.07	Lighting and traction. Arc £23 ..	56

.. ..	2 Poebles, 4 Siemens	870	795 D.C 521	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd., armd. direct and	£51,550	19,900	48 arc, 20	50=112 H.P.	30=450 H.	34,80	
47	BURNLEY	Corporation	1893	R. Birkett ..	220 & 440	Direct ..	5 Lanc., stokers, econ.	3 Burnley Iron Works,				
48	BURTON-ON-TRENT ..	Corporation	1894	P. J. Pringle ..	100 & 200	75∽, 1-ph	6 Lanc., econ., cond.	3 Fowler; 1 Alley - M				
49	BURY (LANCS.) ..	Corporation	1896	S. J. Watson ..	220, 440 & 500	Direct ..	5 Lanc., econ., cond.	Willans (tr.) 6 Belliss..				
50	BURY ST. EDMUNDS..	Corporation	1900	L. P. Greig ..	200 & 400	Direct ..	2 Lanc., detart., econ...	3 Belliss..				
51	BUXTON	Urban District Council	1900	W. J. Leaming ..	230	Direct ..	6 Hornsby w.t., cond.	6 Belliss				
52	CAMBORNE, REDRUTH AND ILLOGAN	Urban Electric Supply Co.	1902	F. S. Hanning ..	240 & 480	Direct ..	2 Lanc.	4 Belliss..				
53	CAMBRIDGE	Cambridge Elec. Supply Co. ..	1892	H. B. Harvey ..	200	90∽, 1-ph.	4 Lanc., econ.	7 Parsons turbines ..				
54	CANTERBURY	Corporation	1899	C. A. Blascheck	220	Direct ..	4 Lanc., stokers, econ., cond.: 1 B. & W. with 2-cell Beaman & Deas destr.	4 Belliss..				
55	CARDIFF..	Corporation	1894	Arthur Ellis ..	200, 400 & 500	40∽, 1-ph. & direct	5 dryback, 3 B. & W., suphtrs., cond.	2 Paxman, 3 Belliss, 1 P				
56	CARLISLE	Corporation	1899	C. D. Burnet ..	230 & 460, 500 tr.	Direct ..	5 Lanc., stokers, econ., cond.	6 Willans				
57	CARLOW	J. Alexander	1890	O. St. J. McKee	100 & 200	70∽, 1-ph., & direct	1 B. & W.	1 Belliss; 2 Waverley turbines (water)				
58	CATERHAM	Urban Electric Supply Co.	1903	F. Bruton ..	420	Direct ..	2 Sugden	2 Belliss..				
59	CHAGFORD	C. & Devon Electric Light Co. ..	1891	G. H. Reed ..	100	99∽, 1-ph.	.. ..	Water-wheel				
60	CHATHAM AND ROCHESTER	C., R. & District Elec. Ltg. Co. ..	1888	C. T. Linney ..	100 & 200	100∽, 1-ph.	1 Lanc., 3 B. & W., cond., clg. tr.	3 Marshall, 1 Robey, 1 P				
61	CHELMSFORD	C. Electric Lighting Co.	1890	A. H. French ..	100 & 200	100∽, 1-ph., & direct	2 Lanc., 2 B. & W., ch. g. stokers	6 Willans, 1 Peache ..				
62	CHELTENHAM	Corporation	1895	M. H. Kilgour ..	100 & 200	100∽, 1-ph., & direct	1 Lanc., 6 B. & W., econ.	3 Willans, 4 Belliss, turbines				
63	CHESTER	Corporation	1896	S. E. Britton ..	210	Direct ..	7 B. & W., stokers	7 Belliss..				
64	CHESTERFIELD.. ..	Corporation	1901	R. L. Acland ..	240 & 480	Direct ..	5 B. & W., econ.	4 Belliss..				
65	CHISLEHURST	Chislehurst Electric Supply Co. ..	1899	A. E. Darlington	210	Direct ..	.. ..	.. ..				
66	CHISWICK	Aberystwyth & C. Elec. Supply Corp.	1900	A. W. Money ..	220 & 440	Direct ..	3 Economic, forced draught..	3 Peache				
67	CHRISTCHURCH AND SOUTHBOURNE	Bournemouth & P. Elec. Supply Co.	1903	E. L. Ingram..	250	Direct ..	2 B. & W.	2 Belliss..				
68	CLECKHEATON ..	Urban District Council	1902	A. Pickersgill ..	230 & 460	Direct ..	4 Lanc. (2 fired by Meldrum destructor, 4 cells)..	3 Belliss..				
69	COATBRIDGE AND AIRDRIE	Scottish H. to H. Electric Co. ..	1894	R. S. Draycott ..	240 & 480	Direct ..	3 Lanc., Vicars stokers, cond.	2 Browett-Lindley, 2 Bel				
70	COLCHESTER	Corporation	1898	A. R. Sillar ..	210 & 420	Direct ..	3 Paxman Economic, cond.	6 Peache (Paxman) ..				
71	COLNE	Corporation	1901	A. G. Cooper ..	240	Direct ..	1 B. & W., 1 Lanc., stoker, suphtrs., econ., cond.	1 Parsons turbine, 1 Bell				
72	COLWYN BAY	Urban District Council	1901	A. R. Tudman ..	220 & 440	Direct ..	2 B. & W.	3 Browett-Lindley, 1 Sto				
73	CORK	C. Elec. Tramways & Lighting Co.	1898	H. H. Nalder ..	230 & 460	Direct ..	6 B. & W.	2 Allis, 3 McIntosh & Belliss				
74	COVENTRY	Corporation	1895	J. A. Jeckell ..	200	87∽, 1-ph. & 50∽, 2-ph.	4 Lanc., stokers, econ., cond.	3 Fowler, 1 Belliss, 2 Mc				
75	COWES	I. of W. Electric Light & Power Co...	1903	F. T. Crowe ..	240 & 480	Direct ..	.. ..	.. ..				
76	CREWE	Corporation	1900	H. H. Denton ..	230	Direct ..	3 Lanc., stokers, econ., cond.	3 Willans				
77	CROMER	Cromer Electricity Supply Co. ..	1903	Edgar Hesketh..	240	Direct ..	2 Sugden water tube, suphtrs.	2 Belliss				
78	CROYDON	Corporation	1896	Alex. C. Cramb..	200 A.C. & 230 D.C.	60∽, 1-ph. & direct	5 Paxman, 6 B. & W., 2 Danks multitub., 3 clg. trs., suphtrs., econ.	11 Belliss				
79	DARLINGTON	Corporation	1900	J. R. P. Lunn ..	230 & 460	Direct ..	4 Lanc.	4 Scott & Mountain, 2 Al				
80	DARTFORD	Urban District Council	1901	A. J. C. Waterland	230 & 460	Direct ..	3 Lanc., stokers, cond.	3 Reavell				
81	DARTMOUTH	Urban Electric Supply Co.	1902	G. E. Smith ..	240	Direct ..	2 B. & W., suphtrs., Boby heater	2 Belliss..				
82	DARWEN	Corporation	1899	C. Garnett ..	230 & 460	Direct ..	4 Lanc., stokers, cond., Meldrum 2-cell destructor	4 Belliss..				
83	DERBY	Corporation	1893	T. P. Wilmshurst	100 & 200	40∽, 1-ph.	6 Lanc., 5 B. & W., econ.	3 Ferranti, 5 Browett-Lind sons turbines				
84	DEVONPORT	Corporation	1901	J. W. Spark ..	230, 460 & 500	Direct ..	5 B. & W., cond., feed htrs., econ.	1 Browett-Lindley, 3 Ferr				
85	DEWSBURY	Corporation	1894	R. H. Campion..	220 & 440	Direct ..	4 Lanc., econ.	7 Willans, 1 Belliss ..				
86	DISS	Suffolk Electricity Supply Co. ..	1898	Napier Prentice	200	Direct ..	.. ..	2 Stockport (gas) ..				
87	DONCASTER	Corporation	1900	E. S. Rayner ..	230	Direct ..	4 Lanc., stokers	7 Willans				
88	DOVER	Corporation	1895	L. W. Woodman	100 &200A.C. 500 D.C.	100∽, 1-ph. & direct	6 B. & W., econ., cond.	4 Brush, 2 Macintosh & 1 Ball & Wood, 1 Ferra				
89	DUBLIN	Corporation	1892	M. Ruddle ..	200	50∽, 1-ph. & 3-ph.	4 B. & W., 6 Lanc.	4 Stewart				
90	DUDLEY	Corporation	1899	C. Ashmore	230 & 460	Direct ..	6 B. & W., stokers, feed htrs., econ., cond. ..	4 Westinghouse, 1 Ferrant				
91	DUNDEE	Corporation	1893	H. Richardson Baker..	200 & 400	Direct ..	8 Lanc., cond., feed htrs , econ., 2 B. & W. ..	11 Willans				
92	DURHAM	County of D. Elec. Power Dist. Co.	1902	A. S. Esslemont	230 & 460	Direct ..	2 B. & W., suphtr., cond.	3 Brush				
93	EALING	Corporation	1894	J. Douglas Knight	102	40∽, 1-ph.	6 Lanc., 4 stokers, cond. 1 Stirling	4 Browett-Lindley, 3 Bel				
94	EASTBOURNE	Corporation	1882	J. K. Brydges ..	200	50∽, 1-ph.	2 Stirling, 2 Hornsby, 1 Economic, 1 B. & W. ..	2 Ferranti, 2 Willans, 1 Pe				
95	EAST HAM	Urban District Council	1901	W. C. Ullmann	240 & 480	Direct ..	6 B. & W., cond., clg. tr., 1 Boby heater	5 Musgrave				
96	ECCLES	Corporation	1898	H. W. Angus ..	200	50∽, 1-ph.	2 Lanc.	3 Browett-Lindley ..				
97	EDINBURCH	Corporation	1895	F. A. Newington	230	50∽, 1-ph. & direct	36 marine, 4 water tube, with stokers	28 Willans, 4 Belliss ..				
98	EPSOM	Urban District Council	1902	H. F. Foster ..	230 & 460	Direct ..	2 Lanc., econ., 1 dryback, cond. and spray ..	2 Alley & MacLellan, 1 Be				
99	ERITH	Urban District Council	1903	Geo. E. Heath ..	3,000, 350, & 200	50∽, 3-ph.	2 Lanc., cond.	3 Allen				
100	EXETER	Corporation	1889	H. D. Munro ..	100	100∽, 1-ph.	5 B. & W., 1 suphtr., feed htrs.	3 Fowler, 1 Easton, 1 Brus Hargreaves, 2 Alley &				
101	FALKIRK	Corporation	1903	J. McMillan ..	250	Direct ..	2 Dryback marine, feed heater & econ.	3 Belliss..				
102	FAREHAM	Urban District Council	1890	A. Blake ..	100	125∽, 1-ph.	2 loco.. 1 Economic	1 Ransome, 2 Browett-L Peache				
103	FARNWORTH	Urban District Council	1901	J. D. Pember ..	220 & 440, 500 tr.	Direct ..	3 Lanc., econ., cond.	3 Browett-Lindley, 1 Bellis				
104	FAVERSHAM	Corporation	..	G. Sommerville	230 & 460	Direct ..	.. ..	2 Westinghouse, gas ..				
105	FELIXSTOWE	Suffolk Electricity Supply Co. ..	1899	Napier Prentice	200	Direct ..	.. ..	3 Stockport, gas ..				
106	FLEETWOOD	F. & District Elec. Lt. & Pr. Synd.	1900	O. Hansom ..	200 & 400	Direct .	2 B. & W., econ., destructor..	2 Willans				
107	FOLKESTONE	F. Electric Supply Co.	1898	T. Hesketh ..	210	Direct ..	4 Economic (oil burnt in two), 1 B. & W., suphtr., cond.	6 Peache				
108	FORT WILLIAM ..	Fort W. Electric Lighting Co. ..	1896	I. Reid	150 D.C., 300 A.C.	Direct & altg.	.. ..	3 Gilkes turbines and oil e				
109	GALWAY	Galway Electric Co.	1889	James Perry ..	110	Direct ..	1 Dowson gas producer plant	2 Hercules water turbines, gas engine				
110	GATESHEAD	County of Durham E. P. D. Co. ..	1901	A. S. Esslemont	230, 460 & 500	Direct and altg.∽50	8 B. & W., suphtrs. and stokers	5 Brush and Belliss ..				
111	GILLINGHAM	Corporation	1897	A. D. Chalmers	100 & 230	50∽, 3-ph.	3 B. & W.	3 Willans				
112	GLASCOW	Corporation	1892	W. A. Chamen..	250&500 d.c., 6,500 a.c.	25∽, 2-ph. & direct	18 B. & W.	9 Willans, 4 Belliss, 1 Paul Wood, 2 Mirrlees Watso & MacLellan				
113	GLOSSOP	Urban Electric Supply Co.	1902	C. E. Knowles ..	240 & 480	Direct ..	2 Economic	3 Belliss				
114	GLOUCESTER	Corporation	1900	W. J. Bache ..	220 & 440	Direct ..	4 Lanc., stokers, econ.	2 Belliss, 1 Willans ..				
115	GODALMING	Urban Electric Supply Co.	1902	R. S. Robertson	240	Direct ..	3 B. & W., chain grates, Boby feed heater ..	3 Belliss				
116	GORSEINON	Gorseinon Electric Light Co. ..	1894	D. Powell ..	200	Direct ..	1 Cornish (Harvey)	1 Thos. White, 1 Powis				
117	GOVAN	Corporation	1900	T. C. Parsons ..	250 & 500	Direct ..	5 B. & W.	4 Belliss, 1 Browett Lindley				
118	GRANTHAM	Urban Electric Supply Co.	1903	W. E. Milns ..	240 & 480	Direct ..	3 Hornsby, suphtr., Boby feed heater	3 Belliss..				
119	GRAVESEND	Corporation	1902	C. F. McInnes ..	230	Direct ..	3 B. & W., stokers, econ. and detart.	3 Alley & Maclellan ..				
120	GRAYS THURROCK ..	Urban District Council	1901	E. D. Long ..	230 & 460	Direct ..	2 Lanc., Meldrum destructor and Lanc. blr., 2 cells	2 Reavell				
121	GREENOCK	Corporation	1899	J. A. Robertson	250 & 500	Direct ..	6 B. & W., stokers, econ., cond.	7 Belliss..				
122	GRIMSBY	Corporation	1901	W. A. Vignoles..	230 & 460	Direct ..	4 Lanc., 1 Stirling, econ., cond. clg. tr.	8 Belliss				
123	GUERNSEY	Guernsey Electricity Supply Co. ..	1900	A. G. Bird ..	210 & 420	Direct ..	4 B. & W., econ.	4 Belliss				
124	GUILDFORD	Guildford Electricity Supply Co. ..	1896	H. L. Alderton..	215	Direct ..	3 B. & W., stokers, cond.	6 Willans, 1 Diesel (oil)				
125	HALIFAX	Corporation	1894	W. M. Rogerson	230	Direct ..	6 B. & W., stokers, econ.	3 Belliss, 1 Pollit, 2 Parsons				

0=450 H.P.	34,800	25.9 (lg.)	Lg. 3, to 4., pr. 2., tr. ½ to 1½	Sliding scales & flat rate	660,962	..	1.65	2.07	Lighting and traction. Arc £23	..	56		
3 Burnley Iron Works, 4 Belliss ..			Parker, 1 Goolden 3 Parker, 2 E.C.C., 2 Dick Kerr ..	1,500	1,247	hrs. Tudor, ltg. 66 KW., tr. 250 KW. max. dis.			Fdrs. armd. and solid, dist. solid various makers ..	£85,604	37,5
3 Fowler; 1 Alley - Maclellan; 3 Willans (tr.)			3 Fowler, 1 Brown-Boveri; 3 B. T. H. (tr.)	810	370	.. ..			B.I. & H. h.p., conc.; Silvertown v. r. single and B.I. & H., conc. l.p., part solid, part iron pipes for both	£60,000	28
6 Belliss..			6 Siemens	1,310	487	E. P. S., lg. 132 KW., tr. 225 KW., for 1 hr.			V.r. and v. bit., lead covd., in c.i. and stoneware pipes and solid	£71,000	
3 Belliss..			3 Fowler	282	165.5	E. P. S., max. dis. 200 KW. ..			Callender, triple conc. and 3-core armd.	£27,748	6
6 Belliss			6 M. & P., 2 Sunderland Forge, 1 E. C. C.	538	202.5	Tudor, 250 amp.-hrs.			Callender, conc., jute, lead covd. and armd., laid direct	£41,550	14
4 Belliss..			5 Parker	480	250	Chloride, max. dis. 200 KW. ..			Callender, laid solid	..	5
7 Parsons turbines			7 Parsons	1,500	574	.. ..			Paper ins., fdrs. twin, dist. 3-core	£86,282	43
4 Belliss..			6 Silvertown, 2 Johnson & Phillips	600	389	Chloride..			Western Elec. triple conc., lead covd. and armd, direct, also Siemens & Henley	£52,248	18
2 Paxman, 3 Belliss, 1 Ferranti ..			5 Siemens, 1 Ferrant	1,560	918 A.C. 795 D.C	Tudor, max. dis. 500 KW. ..			V. r. conc., ppr., armd., Siemens and B.I. & H. ..	£189,134	84
6 Willans			2 Peebles, 4 Siemens	870	521	Chloride, 27.6 KW. for 5 hrs			Callender, conc. v. bit. lead covd., armd. direct and solid; B. I. & H. single solid in c. i. troughs	£51,550	19
1 Belliss; 2 Waverley, 1 Vortex, turbines (water)			2 E. C. C., A. C.; 3 Laurence Scott, D.C.	115	..	Chloride, 40 KW. for 4 hrs. ..			H.P. p. r. in ducts; and covd. overhead; l.p. covd. overhead	..	
2 Belliss..			2 G.E.C...	88	41	D.P., max. dis. 43 KW. ..			Callender, fdrs. tri. conc. armd., dist. lead covd., steel taped, 3-core	£20,000	1,2
Water-wheel			2 Siemens	22	19	.. ..			B.I. & H., ppr., lead covd.	..	
3 Marshall, 1 Robey, 1 Parsons ..			2 Mordey, 2 Ferranti, 1 Parsons ..	900	337	.. ..			Brooks semi-solid, Glover & Henley armd. conc. ..	£54,000	16
6 Willans, 1 Peache			8 Crompton	615	358	Chloride, max. dis. 36 KW. ..			Henley h.p. ppr. conc., dist. v.r. and ppr.	£53,578	13
3 Willans, 4 Belliss, 2 Parsons turbines			5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..			Callender, bit. fibre	£133,062	34
7 Belliss..			6 Parker, 1 Mather & Platt	1,250	831	E. P. S., 110 KW. & Tudor 125 K.W. for 1 hr.			Callender, bit. fibre, lead covd. and armd., conc. and triple conc.	£83,542	47
4 Belliss..			4 Westinghouse	600	369	Chloride, max. dis. 150 KW...			B. I. & H. conc. and triple conc., solid throughout ..	£43,785	16
.. ..			2 Parker motor transformers ..	80	50	D. P., 20 KW. for 5 hrs. ..			Callender, fdrs. triple conc., dist. 3-core	£20,000	6
3 Peache			3 Johnson & Phillips	498	396	Tudor, 132 KW.-hrs.			Fdrs. drawn in, dist. solid, B.I. & H., T.C.C. and J. & P.	..	17
2 Belliss..			2 Siemens	200	..	Tudor, max. dis. 96 KW. ..			3-wire, single, sheathless, solid in asphalte troughs, ..	..	
3 Belliss..			3 Johnson Lundell	450	400	E. P. S., max. dis. 115 KW. ..			B.I. & H. fdrs., tri. conc., dist., 3-single laid solid in wood troughs	£22,685	1
2 Browett-Lindley, 2 Belliss.. ..			2 Brush, 2 Mavor & Coulson ..	800	150	Tudor, 480 amp.-hrs.			Callender, fdrs. three single, dist. triple conc.	..	10
6 Peache (Paxman)			5 Siemens, 1 Mather & Platt ..	935	283	E. P. S., 300 KW. hrs. & Hart., max. dis. 294 KW.			Siemens & Henley, lead covd. jute, fdrs. in conduits; dist., 3-core, armd.	£51,369	22
1 Parsons turbine, 1 Belliss			1 Parsons, 2 Greenwood & Batley ..	200	53.5	P. T. L., 30 KW. for 9 hrs. ..			B.I. & H., fdrs. triple conc., dist. 3-core, ppr., lead covd.	£26,000	5
3 Browett-Lindley, 1 Stockport (gas)			4 Bertram Thomas	315	200	Tudor, max. dis. 44 KW. ..			Glover, p. r., diatrine, lead covd., armd. direct	£18,000	10
2 Allis, 3 McIntosh & Seymour, 1 Belliss			6 B. T. H.	1,250	801	Tudor, 1,700 amp.-hrs. ..			B.I. & H., lead covd, ppr., Callender lead covd. and armd. jute	£315,000	30
3 Fowler, 1 Belliss, 2 McLaren ..			2 Fowler, 1 Fynn, 1-ph.; 2 British Schuckert, 2-ph.	1,800	526	.. ..			B.I. & H. and Siemens, ppr., lead covd, conc.; fdrs. solid, dist. armd. direct and in pipes	£102,712	33
.. ..			2500: 500 volt Parker D. C. transformer	105	65.5	D. P., max. dis. 144 KW. ..			Callender, fdrs. triple conc. jute, dist. 3-core, jute, lead covd. armd. direct	£28,675	5
3 Willans			3 Mather & Platt	520	312	Hart, max. dis. 175 KW. ..			Henley, ppr. & v. r. in wood troughs	£44,167	14
2 Belliss..			2 Parker..	172	..	D. P., max. dis. 164 KW. ..			Callender, v bit. 3 single, laid solid in wood troughs ..	..	4
11 Belliss			9 B.T.H., 1 E.C.C., 1 Dick Kerr ..	4,165	2,161	Tudor, max. dis. 50 KW. ..			Callender, v.b. fibre and paper	£231,343	104
4 Scott & Mountain, 2 Allen ..			6 Scott & Mountain, 2 Parker ..	692	279	D. P., max. dis. 48 KW. ..			Callender, fdrs. conc., dist. tri. conc.; lead covd. solid in wood & armd. direct	£39,921	20
3 Reavell			2 G. E. C., 1 Lanc. Dynamo Co. ..	500	..	A. B. P., 50 KW. for 3 hrs. ..			Fdrs. triple conc., dist. 3-core. all ppr. lead covd. solid	£34,000	6
2 Belliss..			2 Parker	180	72	D. P., max. dis. 168 KW. ..			Callender, v.-bit., lead covd., armd.	..	5
4 Belliss..			2 Siemens, 1 Mather & Platt, 1 Peebles	900	780	Tudor, 500 amp.-hrs.			Callender, armd. fdrs. and dist., also Doulton conduit	£55,224	12
3 Ferranti, 5 Browett-Lindley, 3 Parsons turbines			3 Ferranti, 5 Siemens, 3 Parsons ..	3,200	1,250	Chloride, max. dis. 320 KW. ..			Paper and jute conc., and sing. bit. solid; B.I. & H., Callender, Glover & Siemens	£157,150	67
4 Browett-Lindley, 3 Ferranti ..			4 E. C. C.	1,360	Lg. 201, tr. 550	A. B. P., max. dis. 420 KW. ..			Callender, v. b. lead covd. and armd., and solid ..	£102,057	10
7 Willans, 1 Belliss			3 Crompton, 2 Peebles, 1 Dick Kerr, 3 Siemens	750	Lg. 320, tr. 300	Tudor, 90 amp. for 4 hrs. ..			Fdrs. 3 and 2 conc., dist. single, all lead covd., armd. direct. Siemens, Callender, B.I. & H.	£47,350	18
2 Stockport (gas)			1 Prentice, 1 Anglian..	48	22	Chloride, max. dis. 40 KW. ..			Overhead, bare copper	..	1,2
7 Willans			7 Mather & Platt, and Bruce Peebles	909	606	E.P.S., max. dis. 23 KW. ..			Callender, fdrs. fibre, single, lead sh.; dist. armd. ..	£45,700	25
4 Brush, 2 Macintosh & Seymour, 1 Ball & Wood, 1 Ferranti			1 Ferranti, 4 Brush, A.C.; 3 G.E.C. (Am.), D.C.	1,250	599	Tudor, max. dis. 77 KW. ..			Fdrs., v.r. conc., Silvertown; dist. ppr. conc., lead covd., B.I. & H. and Glover in pipes	£103,251	27
4 Stewart			4 Oerlikon	3,000	1,640	.. ..			Callender and B.I. & H.	£300,000	65
3 Westinghouse, 1 Ferranti			4 Westinghouse, 1 E.C.C.	1,200	Ltg. 354, tr. 850.	.. ..			Callender triple conc., lead covd., and v. bit, solid ..	£45,000	19
11 Willans			1 Dick Kerr, 6 Siemens, 3 Parker, 1 Int. E. E. Co.	3,010	1,750	E. P. S., max. dis. 70 KW. ..			B.I. & H. &, Callender, fdrs., bare cpr., single lead covd. and v.bit. dist., l. covd., ppr., v. bit., solid in Doulton con.	£163,000	65
3 Brush			3 Brush	400	151	Hart, 240 amp.-hrs.			Callender, solid	..	6
3 Browett-Lindley, 3 Belliss, ..			Siemens, 4 A C., 3 arc (1,800 v. D. C.)	1,196	852	Tudor, max. dis. 93.78 KW. ..			Callender, also Siemens and J & P., jute (h.p.) and v. bit. l.p.)	£158,078	67
3 Ferranti, 2 Willans, 1 Peache ..			2 Ferranti, 3 E.C.C.	1,200	743	.. ..			Glover fdrs., ppr., conc., solid; St. Helens twin dist.	£135,500	61
3 Musgrave			5 Dick Kerr	1,275	690	.. ..			Callender, single lead covd., fdrs. in conduits, dist. solid	..	27
3 Browett-Lindley			2 J. & P., 1 Rosling	280	135	Pritchetts, 16 KW. for 9 hrs.			H.p. conc., Glover diatrine, and B.I. & H., l.p. twin. Callender, solid	£19,302	10
8 Willans, 4 Belliss			18 Siemens, 10 Mather & Platt, 4 Ferranti, 2 E.C.C.	11,257	8,092	Tudor & Pritchetts, max. dis 1,304 K.W.			.. ..	£765,612	513
3 Alley & MacLellan, 1 Belliss ..			2 Laurence Scott, 1 Dick Kerr ..	260	..	Pritchetts, 46 KW. for 3 hrs...			Callender, solid and direct	£27,100	5
3 Allen			3 International Elec. Eng.	350	85	.. ..			Callender, lead covd., ppr., laid solid, h.p. armd., ..	£43,000	3
3 Fowler, 1 Easton, 1 Brush, 1 Hick Hargreaves, 2 Alley & MacLellan			4 Mordey, 1 Fynn, 1 Ferranti, 2 Thomson-Houston arc.	670	412	.. ..			Concentric	£32,000	26
3 Belliss..			3 Mavor & Coulson	300	125	E. P. S. max. dis. 70 KW. ..			Callender, triple conc., vulc. bit. lead covd.	£24,000	3
1 Ransome, 2 Browett-Lindley, 1 Peache			2 Thomson-Houston, 1 Johnson-Phillips, A.C.; 2 T. H. arc.	140	63	.. ..			B.I. & H. twin and conc., and Okonite	£11,490	3
3 Browett-Lindley, 1 Belliss.. ..			3 Lanc. Dynamo Co., 1 Westinghouse	610	397	Tudor, 160 amp., max.			B.I.&H. 5-core, lead covd. and armd. fdrs., 3-core dist., and Glover 3 single lead covd., armd. solid in Howard conduit	£36,064	7
2 Westinghouse, gas			2 Westinghouse	120	..	E. P. S., max. dis. 230 KW. ..			V. bit. 3 single, and 3-core, Anchor	..	
3 Stockport, gas			1 Bruce Peebles, 1 Prentice, 1 Anglian	113	101	Chloride, max. dis. 20 KW. ..			Overhead, bare copper	..	7
2 Willans			2 Johnson-Phillips	120	96	Chloride, 600 amp.-hrs. ..			Triple conc. and 3-core ppr. lead covd. and armd. ..	£30,000	8
5 Peache			6 Parker	1,000	624	Tudor, max. dis. 2 KW. ..			Callender fdrs. tri. conc.; dist. 3-core	£138,827	
3 Gilkes turbines and oil engine ..			2 Laurence Scott, 1 General Electric	120	190	E. P. S. max. dis. 30 KW. ..			Overhead, and underground, Glover dia. armd... ..	£11,091	6
2 Hercules water turbines, 1 Crossley gas engine			3 Statter, 2 Crompton, 1 Holmes, geared	153	84	Tudor, 24 KW. for 3 hrs. ..			Bare copper and diatrine single in bitumen	£10,000	3
5 Brush and Belliss			7 Brown Bostri, Brush, Siemens & Halske (D.C. 2,100 KW., A.C. 750 KW.)	2,850	..	Pollak, traction; Hart, lighting			Callender, fdrs., tri. conc.; dist., 3-core, solid in wood troughs	..	
3 Willans			3 B. T. H.	550	170	.. ..			Henley, tdrs. 3-core, dist. 4-core	..	
9 Willans, 4 Belliss, 1 Paul, 1 Ball & Wood, 2 Mirrlees Watson, 1 Alley & MacLellan			7 Crompton, 2 Westinghouse, 3 Peebles, 2 Walker, 2 Schuckert, 2 B. T. H., 2 Brit. Elec. Plant	10,443	9,371	Tudor, max. dis. 840 KW. ..			Callender and B. I. twin conc. fdrs., triple conc. and conc. dist.	£1,041,746	494
3 Belliss			3 Parker	..	..	D. P., 400 amp.-hrs.			Callender single, laid solid	..	
2 Belliss, 1 Willans			4 Silvertown, 2 Mather & Platt ..	750	304	E. P. S., 1,000 amp.-hrs. ..			Callender, triple conc., solid	£59,047	20,0
3 Belliss			3 Fowler..	380	133	D. P., max. dis. 90 KW. ..			Callender, v. bit. solid, in wood trough, for public lamps 3-core lead covd. and armd.	..	9,2
1 Thos. White, 1 Powis			1 Elwell Parker, 1 E. C. C.	60	32	.. ..			Overhead 2-wire, Henley, vulcanized rubber	£1,800	1,
4 Belliss, 1 Browett Lindley.. ..			2 B. T. H., 1 Silvertown, 1 Dick Kerr, 1 L. D. & M.	1,200	600	Tudor, max. dis. 200 KW. ..			Callender & Glover, single lead covd. and armd. ..	£65,000	24,
3 Belliss..			3 Parker	380	156	D. P., max. dis. 68 KW. ..			Callender 3-way solid and 3-core armd., v. bit. ..	£47,580	13,
3 Alley & Maclellan			3 Lancashire Dynamo Co.	600	..	Pritchetts, 500 amp.-hrs. ..			Western Electric lead covd., ppr., solid	£35,000	
2 Reavell			2 British Schuckert	200	100	D.P., max. dis 60 KW. ..			Callender, triple conc. bit. armd. direct, and 3-core for st. ltg.	£18,600	6,
7 Belliss..			8 Silvertown	1,400	796	Tudor, 140 KW. normal dis...			Callender, vulc. bit., solid and in C.W. casing	£40,424	25,
3 Belliss			8 Mather & Platt, 2 Westinghouse..	900	..	Tudor, max. dis. 125 KW. ..			Fdrs. B.I. and Anchor, conc., paper, lead covd., solid, dist. B.I., J. & P. and Anchor, triple conc.	£72,000	25,
4 Belliss			4 Parker	510	368	D. P., max. dis. 150 KW.; Tudor, max. dis. 336 KW.			Callender, fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid	£108,500	24,
3 Willans, 1 Diesel (oil)			3 Jackson, 2 Rosling, 2 Taunton ..	430	192	Niblett, max. dis. 45 KW. ..			Callender, v. bit. and fibre, iron armd.	£37,888	15,
3 Belliss, 1 Pollit, 2 Parsons turbines			6 E. C. C., 2 Parsons	4,750	2,299	Chloride, 400 amp.-hrs. ..			B.I. & H. and Callender, paper and bit.	£213,579	94,8

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Parker, 1 Goolden	..	..	hrs.	Overhead	..	1,300	16 inc. ..	..	
3 Parker, 2 E.C.C., 2 Dick Kerr ..	1,500	1,247	Tudor, ltg. 66 KW., tr. 250 KW. max. dis.	Fdrs. armd. and solid, dist. solid various makers ..	£85,604	37,223	110 eq. 8 c.p.	181 H.P.	
3 Fowler, 1 Brown-Boveri ; 3 B. T. H. (tr.)	810	370	.. ..	B.I. & H. h.p., conc. ; Silvertown v. r. single and B.I. & H., conc. l.p., part solid, part iron pipes for both	£60,000	23,708	1 arc ..	17=115 H	
6 Siemens	1,310	487	E. P. S., lg. 192 KW., tr. 225 KW., for 1 hr.	V.r. and v. bit., lead covd., in c.i. and stoneware pipes and solid	£71,000	..	..	..	
3 Fowler	232	165.5	E. P. S., max. dis. 200 KW. ..	Callender, triple conc. and 3-core armd.	£27,748	6,104	14 arc, 405 inc.	13=75 H.	
6 M. & P., 2 Sunderland Forge, 1 E. C. C.	538	202.5	Tudor, 250 amp.-hrs.	Callender, conc., jute, lead covd. and armd., laid direct	£41,550	14,905	..	16=40 H.	
5 Parker	480	250	Chloride, max. dis. 200 KW. ..	Callender, laid solid	..	5,121	2 arc, 180 inc.	23=200 H	
7 Parsons	1,500	574	.. ..	Paper ins., fdrs. twin, dist. 3-core	£86,282	43,913	1 arc ..	10=32 H.	
6 Silvertown, 2 Johnson & Phillips	600	389	Chloride..	Western Elec. triple conc., lead covd. and armd., direct, also Siemens & Henley	£52,248	18,765	12 arc, 440 inc. 19 Nernst	31=66 H.	
5 Siemens, 1 Ferrant	1,560	918 A.C. 795 D.C	Tudor, max. dis. 500 KW. ..	V. r. conc., ppr., armd., Siemens and B.I. & H. ..	£189,134	84,548	420 arc, 115 inc.	120=532 H	
2 Peebles, 4 Siemens	870	521	Chloride, 27.6 KW. for 5 hrs	Callender, conc. v. bit. lead covd., armd. direct and solid; B. I. & H. single solid in c. i. troughs	£51,550	19,900	48 arc, 20 Nernst	50=112 H	
2 E. C. C., A. C. ; 3 Laurence Scott, D.C.	115	..	Chloride, 40 KW. for 4 hrs. ..	H.P. p.r. in ducts; and covd. overhead; l.p. covd. overhead	..	..	13 arc, 80 inc.	1=67 H.P.	
2 G.E.C...	88	41	D.P., max. dis. 43 KW. ..	Callender, fdrs. tri. conc. armd., dist. lead covd., steel taped, 3-core	£20,000	1,634	..	..	
2 Siemens	22	19	.. ..	B.I. & H., ppr., lead covd.	..	..	16 inc. ..	..	
2 Mordey, 2 Ferranti, 1 Parsons ..	900	337	.. ..	Brooks semi-solid, Glover & Henley armd. conc. ..	£54,000	16,917	..	2=12 H.P.	
8 Crompton	615	358	Chloride, max. dis. 36 KW. ..	Henley h.p. ppr. conc., dist. v.r. and ppr.	£53,578	13,969	320 arc, 1,100 inc.	30=121 H	
5 Siemens (2 D.C., 3 A.C.), 2 Parsons A.C., 2 Witting D.C.	1,700	750	Tudor, 60 KW. for 3 hrs. ..	Callender, bit. fibre	£133,062	34,556	331 arc, 19 inc.	7=40 H.P.	
6 Parker, 1 Mather & Platt	1,250	831	E. P. S., 110 KW. & Tudor 125 K.W. for 1 hr.	Callender, bit. fibre, lead covd. and armd., conc. and triple conc.	£83,542	47,558	211 arc, 1,025 inc., 8 N.	175 H.P.	
4 Westinghouse	600	369	Chloride, max. dis. 150 KW...	B. I. & H. conc. and triple conc., solid throughout ..	£43,785	16,700	20 arc, 40 inc.	40=208 H	
2 Parker motor transformers ..	80	50	D. P., 20 KW. for 5 hrs. ..	Callender, fdrs. triple conc., dist. 3-core	£20,000	6,600	..	..	
3 Johnson & Phillips	498	396	Tudor, 132 KW.-hrs.	Fdrs. drawn in, dist. solid, B.I. & H., T.C.C. and J. & P.	..	17,115	..	322 ..	
4 Siemens	200	..	Tudor, max. dis. 96 KW. ..	3-wire, single, sheathless, solid in asphalte troughs, ..	..	..	..	..	
2 Johnson Lundell	450	400	E. P. S., max. dis. 115 KW. ..	B.I. & H. fdrs., tri. conc., dist., 3-single laid solid in wood troughs	£22,685	1,310	3 arc ..	8=19 H.P.	
1 Brush, 2 Mavor & Coulson ..	800	150	Tudor, 480 amp.-hrs.	Callender, fdrs. three single, dist. triple conc.	..	10,200	22 arc, 214 inc.	22½ H.P.	
2 Siemens, 1 Mather & Platt ..	935	283	E. P. S., 300 KW. hrs. & Hart., max. dis. 294 KW.	Siemens & Henley, lead covd. jute, fdrs. in conduits; dist., 3-core, armd.	£51,369	22,838	14 inc., 157 Nernst	15=50 H.	
2 Parsons, 2 Greenwood & Batley ..	260	53.5	P. T. L., 30 KW. for 9 hrs. ..	B.I. & H., fdrs. triple conc., dist. 3-core, ppr., lead covd.	£26,000	5,018	..	11=23 H.	
2 Bertram Thomas	315	200	Tudor, max. dis. 44 KW. ..	Glover, p. r., diatrine, lead covd., armd. direct	£18,000	10,100	32 arc ..	1=5 H.P.	
3 B. T. H.	1,250	801	Tudor, 1,700 amp.-hrs. ..	B I. & H., lead covd, ppr., Callender lead covd. and armd. jute	£315,000	30,652	85 arc, 51 inc.	114=873 H	
1 Fowler, 1 Fynn, 1-ph. ; 2 British Schuckert, 2-ph.	1,800	526	.. ..	B.I. & H. and Siemens, ppr., lead covd., conc. ; fdrs. solid, dist. armd. direct and in pipes	£102,712	39,605	40 arc ..	58=346 H	
500: 500 volt Parker D. C. transformer	105	65.5	D. P., max. dis. 144 KW. ..	Callender*, fdrs. triple conc. jute, dist. 3-core, jute, lead covd. armd. direct	£28,675	5,993	..	8=17 H.P.	
Mather & Platt	520	312	Hart, max. dis. 175 KW. ..	Henley, ppr. & v. r. in wood troughs	£44,167	14,569	8 arc, 714 posts (inc.)	23=65 H.	
Parker..	172	..	D. P., max. dis. 164 KW. ..	Callender, v bit. 3 single, laid solid in wood troughs ..	..	4,580	10 arc., 20 inc.	5=8 H.P.	
B.T.H., 1 E.C.C., 1 Dick Kerr ..	4,165	2,161	Tudor, max. dis. 50 KW. ..	Callender, v.b. fibre and paper	£231,343	104,713	399 arc, 26 inc. 38 Nernst	35=85 H.	
Scott & Mountain, 2 Parker ..	692	279	D. P., max. dis. 48 KW. ..	Callender, fdrs. conc., dist. tri. conc. ; lead covd. solid in wood & armd. direct	£39,921	20,284	40 arc ..	30=927 H.	
, E. C., 1 Lanc. Dynamo Co. ..	500	..	A. B. P., 50 KW. for 3 hrs. ..	Fdrs. triple conc., dist. 3-core, all ppr. lead covd. solid	£34,000	6,000	6 arc, 340 inc.	..	
Parker	180	72	D. P., max. dis. 168 KW. ..	Callender, v.-bit., lead covd., armd.	..	5,886	10 arc, 160 inc. 1 Nernst	3=3 H.P.	
Siemens, 1 Mather & Platt, 1 Peebles	900	780	Tudor, 500 amp.-hrs.	Callender, armd. fdrs. and dist., also Doulton conduit	£55,224	12,242	18 arc, 150 inc.	192 H.P.	
Ferranti, 5 Siemens, 3 Parsons ..	3,200	1,250	Chloride, max. dis. 320 KW. ..	Paper and jute conc., and sing. bit. solid; B.I. & H., Callender, Glover & Siemens	£157,150	67,911	79 arc, 370 Nernst	218=1,120 H.P.	
G. C.	1,360	Lg. 201, tr. 550	A. B. P., max. dis. 460 KW. ..	Callender, v. b. lead covd. and armd., and solid ..	£102,057	10,556	20 arc, 1 inc.	13=161½ H	
Crompton, 2 Peebles, 1 Dick Kerr, 1 Siemens	750	Lg. 320, tr. 300	Tudor, 90 amp. for 4 hrs. ..	Fdrs. 3 and 2 conc., dist. single, all lead covd., armd. direct. Siemens, Callender, B.I. & H.	£47,350	18,626	31 arc, 32 inc.	49=206 H.	
Gentice, 1 Anglian..	48	22	Chloride, max. dis. 40 KW. ..	Overhead, bare copper	..	1,200	..	5=8 H.P.	
Mather & Platt, and Bruce Peebles	909	606	E.P.S., max. dis. 23 KW. ..	Callender, fdrs. fibre, single, lead sh.; dist. armd. ..	£45,700	25,720	1 arc ..	266 H.P.	
Ferranti, 4 Brush, A.C. ; 3 G.E.C. D.), D.C.	1,250	599	Tudor, max. dis. 77 KW. ..	Fdrs., v.r. conc., Silvertown; dist. ppr. conc., lead covd., B.I. & H. and Glover in pipes	£103,251	27,400	40 arc, 147 inc.	43=347 H.	
Hilkon	3,000	1,640	.. ..	Callender and B.I. & H.	£300,000	65,000	500 arc ..	60 ..	
Westinghouse, 1 E.C.C.	1,200	Ltg. 354, tr. 850.	.. ..	Callender triple conc., lead covd., and v. bit , solid ..	£45,000	19,226	56 arc, 260 inc.	34=178½ H	
Crompton, 2 Peebles, 1 Dick Kerr, 6 Siemens, 3 Parker, 1 Siemens	3,010	1,750	E. P. S.. max. dis. 70 KW. ..	B.I. & H. &, Callender, fdrs., bare cpr., single lead covd. and v.bit. dist., l. covd., ppr., v. bit., solid in Doulton con.	£163,000	65,300	71 arc ..	158=444 H	
Parsh	400	151	Hart, 240 amp.-hrs.	Callender, solid	..	6,703	..	..	
Fynns, 4 A.C., 3 arc (1,800 v. D. C.)	1,196	852	Tudor, max. dis. 93.78 KW. ..	Callender, also Siemens and J & P., jute (h.p.) and v. bit. l.p.)	£158,073	67,473	74 arc, 1,354 inc. (8 c.p.)	28=100 H.	
Ferranti, 3 E.C.C.	1,200	743	.. ..	Glover fdrs., ppr., conc., solid; St. Helens twin dist.	£135,500	61,567	99 arc ..	32=58 H.	
Dick Kerr	1,275	690	.. ..	Callender, single lead covd., fdrs. in conduits, dist. solid	..	27,823	171 arc, 137 inc.	24=64 H.	
2 P., 1 Rosling	280	135	Pritchetts, 16 KW. for 9 hrs.	H.p. conc., Glover diatrine, and B.I. & H., l.p. twin, Callender, solid	£19,302	10,374	2 arc, 426 inc.	2=6 H.P.	
Siemens, 10 Mather & Platt, Ferranti, 2 E.C.C.	11,257	8,092	Tudor & Pritchetts, max. dis 1,304 K.W.	.. ..	£765,612	513,176	996 arc ..	1,215=5,21 H.P.	
Lence Scott, 1 Dick Kerr ..	260	..	Pritchetts, 46 KW. for 3 hrs...	Callender, solid and direct	£27,100	5,168	12 arc, 276 inc. 24 Nernst	2=16 H.P.	
National Elec. Eng.	350	85	.. ..	Callender, lead covd., ppr., laid solid, h.p. armd.. ..	£43,000	3,500	18 arc, 644 Nernst.	2=12½ H.P.	
Sidey, 1 Fynn, 1 Ferranti, 2 Johnson-Houston arc.	670	412	.. ..	Concentric	£32,000	26,000	33 arc ..	12=40 H.P.	
Parker & Coulson	300	125	E. P. S. max. dis. 70 KW. ..	Callender, triple conc., vulc. bit. lead covd.	£24,000	3,172	41 arc, 82 inc. 16 Nernst	7=15 H.P.	
Johnson-Houston, 1 Johnson-Phillips, A.C. ; 2 T. H. arc.	140	63	.. ..	B.I. & H. twin and conc., and Okonite	£11,490	3,050	27 arc, 109 inc.	..	
1 Dynamo Co., 1 Westinghouse	610	397	Tudor, 160 amp., max. ..	B.I.&H. 5-core, lead covd. and armd. fdrs., 3-core dist., and Glover 3 single lead covd., armd. solid in Howard conduit	£36,064	7,116	133 arc, 136 inc.	388½ H.P.	
Westinghouse	120	..	E. P. S., max. dis. 230 KW. ..	V. bit. 3 single, and 3-core, Anchor	..	..	..	..	
Prentice Peebles, 1 Prentice, Sellian	113	101	Chloride, max. dis. 20 KW. ..	Overhead, bare copper	..	7,000	35 arc ..	10=12 H	
Johnson-Phillips	120	96	Chloride, 600 amp.-hrs. ..	Triple conc. and 3-core ppr. lead covd. and armd. ..	£30,000	8,000	12 arc, 600 inc.	63 H.P.	
.. ..	1,000	624	Tudor, max. dis. 2 KW. ..	Callender fdrs. tri. conc. ; dist. 3-core	£138,837	..	66 arc, 132 inc.	19=73 H.P.	
Lence Scott, 1 General Electric	120	190	E. P. S. max. dis. 30 KW. ..	Overhead, and underground, Glover dia. armd... ..	£11,091	6,000	6 arc, 60 inc.	2=4 H.P.	
Parker, 2 Crompton, 1 Holmes,	153	84	Tudor, 24 KW. for 3 hrs. ..	Bare copper and diatrine single in bitumen	£10,000	3,654	8 arc, 4 inc...	8=8.5 H.P.	
1 Bostri, Brush, Siemens & (D.C. 2,100 KW., A.C. 750 KW.)	2,850	..	Pollak, traction ; Hart, lighting	Callender, fdrs., tri. conc. ; dist., 3-core, solid in wood troughs	..	..	..	..	
.. ..	550	170	.. ..	Henley, fdrs. 3-core, dist. 4-core	..	..	..	..	
Crompton, 2 Westinghouse, 3 , 2 Walker, 2 Schuckert, H., 2 Brit. Elec. Plant	10,443	9,371	Tudor, max. dis. 840 KW. ..	Callender and B. I. twin conc. fdrs., triple conc. and conc. dist.	£1,041,746	494,943	348 arc ..	427=1894 H	
.. ..	..	..	D. P., 400 amp.-hrs.	Callender single, laid solid	..	..	..	..	
Brown, 2 Mather & Platt ..	750	304	E. P. S., 1,000 amp.-hrs. ..	Callender, triple conc., solid	£59,047	20,400	54 arc,	13=32 H.P.	
.. ..	380	133	D. P., max. dis. 90 KW. ..	Callender* v. bit. solid, in wood trough, for public lamps 3-core lead covd. and armd.	..	9,900	943 .. .. 4 Nernst	11=22 H.P.	
Parker, 1 E. C. C.	60	32	.. ..	Overhead 2-wire, Henley, vulcanized rubber	£1,800	1,200	112 inc. ..	..	
H., 1 Silvertown, 1 Dick L. D. & M.	1,200	600	Tudor, max. dis. 200 KW.* ..	Callender & Glover, single lead covd. and armd. ..	£65,000	24,122	100 arc (extending)	650 H.P.	
.. ..	380	156	D. P., max. dis. 68 KW. ..	Callender 3-way solid and 3-core armd., v. bit. ..	£47,580	13,730	..	4=20 H.P.	
Dynamo Co.	600	..	Pritchetts, 500 amp.-hrs. ..	Western Electric lead covd., ppr., solid	£35,000	..	27 arc ..	..	
Schuckert	200	100	D.P., max. dis 60 KW. ..	Callender, triple conc. bit. armd. direct, and 3-core for st. ltg.	£18,600	6,457	404 inc., 20 Nernst	9=27 H.P.	
.. ..	1,400	796	Tudor, 140 KW. normal dis...	Callender, vulc. bit., solid and in C.W. casing	£40,424	25,848	50 arc, 3 Nernst	77=758 H.	
Platt, 2 Westinghouse..	900	..	Tudor, max. dis. 125 KW. ..	Fdrs. B.I. and Anchor, conc., paper, lead covd., solid, dist. B.I., J. & P. and Anchor, triple conc.	£72,000	25,556	80 arc ..	41=167 H.	
.. ..	510	368	D. P., max. dis. 153 KW.; Tudor, max. dis. 836 KW.	Callender, fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid	£108,500	24,367	12 inc. ..	74=770½ H	
Rosling, 2 Taunton ..	480	192	Niblett, max. dis. 45 KW. ..	Callender, v. bit. and fibre, iron armd.	£37,888	15,000	1 arc, 3 Nernst	28=89 H.P.	

												certain areas ds Chislehurst through step-up ransformers, at 2,000 volts 44
												 45
to me ..	..	..	..	..	8.	Flat rate ..	..	..	..	..	Messrs. Gillies & Hornidge, engineers and proprietors	46
110 eq. 8 c.p.	181 H.P. ..	46=3,460 H.P.	122,207	..	Lg. 4., pb. lg 3., pr. 3. & 1., tr. 1¾.	Flat rate & max. dem.	1,739,795	2.32	.764	1.020	Lg. and tr.	47
1 arc ..	17=115 H.P.	40=1,000 H.P.	58,800	12.2 (exc. tr)	Lg. 6. & 3., pr. 3. & 1., or 2. to 1¼.,	Max. demand & sldg. scale	678,020	3.12	1.14	1.52	Lg. & tr. Pb. lg. 3d., tr. 2d. to 1½d.	48
..	..	..	38,071	..	Lg. 6. & 3., or 4½., arc £17½, pr. 3. & 1., tr. 1½.	Max. demand & flat rate	672,911	2.8	..	..	Lg. and tr.	49
4 arc, 405 inc.	13=75 H.P.	Water works 50 H.P.	10,401	21.9	Lg. 6., pr. 3. to 2¾., arc £13, inc. 35s.	Flat rate with dis.	256,022	2.67	1.44	1.83	Corporation water works supplied at 1.75d. per unit	50
..	16=40 H.P.	..	16,000	..	6., 4. & 3. or 7. & 3.	Sliding sc., or max. dem.	146,480	5.22	2.5	3.6	Max. load at end of summer; load through season heavier than in winter	51
2 arc, 180 inc.	23=200 H.P.	20=500 H.P.	25,156	117	Lg. 7. & 4., pr. 4. & 1., tr. 1½.	Max. demand	363,984	2.3	.96	1.24	Lg. and tr.	52
1 arc ..	10=32 H.P.	..	44,088	8.7	Lg. 7., pb. lg. 3., pr. 3½.	Flat rate and contract	471,510	5.88	1.47	2.33	Data to Dec. 31st, 1903	53
2 arc, 440 inc. 19 Nernst	31=66 H.P.	..	21,995	14.6	Lg. 7. & 3. or 6. arc £25, inc. £3½, pr. 3 to 1½	Max. demand or flat rate	401,578	4.06	1.26	1.84	.. ..	54
20 arc, 115 inc.	120=532 H.P	..	109,570	31	Lg. 7. & 2. or 4½., pr. 4. & 1., pb. lg. 1½.	Max. dem., flat & prept.	2,385,472	2.95	1.3	1.5	Centre of town & docks, sup. by D.C. from tramway dept.	55
18 arc, 20 Nernst	50=112 H.P.	30=450 H.P.	34,800	25.9 (lg.)	Lg. 5. to 4., pr. 2., tr. 2. to 1½.	Sliding scales & flat rate	660,962	..	1.65	2.07	Lighting and traction. Arc £23 ..	56
3 arc, 80 inc.	1=67 H.P. ..	..	3,500	..	6. & 3½.	Flat rate with discounts	..	..	..	..	5 miles overhead to Carlow, driving mo. dynamo. Steam plant at C. as stand-by	57
..	..	..	1,634	52	Lg. 7. & 4., pr. 4. & 1½.	Max. demand	..	5.5	..	..	Supply commenced Nov., 1903	58
16 inc. ..	..	..	..	..	6.	Flat rate ..	..	..	..	..	.. ..	59
..	2=12 H.P. ..	..	..	..	Lg. 7. & 4. or 5., pr. 3.	Max. demand or flat rate	..	..	..	..	.. ..	60
320 arc, 1,100 inc.	30=121 H.P.	..	18,234	13.4	Lg. 6., pr. 3., pb. lg. £25 and £3½	Flat rate ..	435,070	4.0	1.988	2.61	Data to Dec. 31st, 1903	61
31 arc, 19 inc.	7=40 H.P. ..	..	..	..	Lg. 6. & 3½, pr. 3. tr. 1.9 to 1.	Max. demand	..	..	..	..	Lighting A.C., Tramway Co. supplied with D.C.	62
211 arc, 1,025 inc., 8 N.	175 H.P. ..	24=600 ..	66,899	16	Lg. 4½., pr. 2. to 1., tr. 1½.	Flat rate with discount	1,202,933	..	..	..	Lg. and tr. Arc £18, 8 c.p. 28/9 ..	63
20 arc, 40 inc.	40=208 H.P.	..	25,500	43.84	Lg. 6. & 3., or 4., pr. 1½., arc £12½	Max. demand & flat	339,934	3.63	.877	1.358	.. ..	64
..	..	..	6,600	..	8. & 4.	Max. demand	..	..	..	..	Fed from Bromley at 2,000 v.	65
..	322	..	25,165	41.7	Lg. 5., pr. 2. ..	Flat rate ..	433,595	3.67	1.61	..	Data to Dec. 31st, 1903	66
..	..	..	..	..	Lg. 7. & 3., pr. 3...	Max. demand & flat rate	..	..	..	..	.. ..	67
3 arc ..	8=19 H.P. ..	500 H.P. ..	15,288	1.79 (lg.)	Lg. 5., pr. 2. & 1., pb. lg. 2., tr. 1.5. to 1.3.	Flat rate & meter w. dis.	244,472	2.12	.80	1.113	Lg. and tr.	68
2 arc, 214 inc.	22½ H.P. ..	..	11,500	..	Lg. 5., pr. 2½." ..	Flat rate ..	..	..	..	..	" Large works 1½d. & 1d.	69
4 inc., 157 Nernst	15=50 H.P.	..	24,836	10.8	Lg. 7. & 4., pr. 4. to 2½., pb. lg. 2½.	Max. demand & scale	402,440	4.43	1.75	2.2	.. ..	70
..	11=23 H.P.	..	..	..	Lg. 6. & 2½. or 4½. pr. 3. & 1. or 2½.	Max. demand & flat rate	51,243	3.95	2.12	3.66	Lg. and tr.	71
2 arc ..	1=5 H.P. ..	..	10,990	6.0	Lg. 5., pb. lg. 4., pr. 3.	Flat rate ..	..	..	..	..	.. ..	72
35 arc, 51 inc.	114=878 H.P.	..	..	..	Lg. 5. to 3., pr. 1½. to 1.	Max. demand & sl. scale	2,393,078	2.7	..	..	Lg. and tr.	73
0 arc ..	58=346 H.P.	..	48,700	..	Lg. 6., 3., 1., pr. 1¾.	Max. demand & flat rate	566,731	3.32	1.024	1.513	Extensions in progress	74
..	8=17 H.P. ..	..	6,469	..	Lg. 7. & 4. or 6., pr. 4. & 1¼. or 2½.	Max. demand & flat rate	37,431	4.5	3.4	4.3	Started May 1903. " Trunk main at 5,000 v. from Newport, Call. solid	75
arc, 714 posts (inc.)	23=65 H.P.	..	18,152	13	Lg. 6. & 3. or 4½., pr. 3. to 1¼., pb. lg. 3.	Max. demand & flat rate	402,308	3.68	.87"	1.23	" Excluding pb. lg.	76
0 arc., 20 inc.	5=8 H.P. ..	..	4,954	23	Lg. 7. & 4. or 6., pr. 4. & 1¼. or 2½., pb. lg. 2½.	Max. demand & flat rate	21,413"	5.2"	..	..	Slot meter, 7d. per unit, inc. rent. " To end of Dec., 1903	77
09 arc, 26 inc. 38 Nernst	85=85 H.P.	120=4,200 H.P.	219,566	23	Lg. 7. & 3. or 5., pr. 2½., tr. 2."	Max. demand & flat rate	3,131,841	3.02	1.27	1.59	Lg. and tr. " Pb. lg. arc £18, inc. £3½	78
0 arc ..	80=927 H.P.	..	23,621	37.5	Lg. 4½. to 4., pr. 2. to 1½., pb.lg. £17½, tr. 1½	Sliding scale	266,311	4.37	1.09	2.0	Lg. and tr.	79
arc, 340 inc.	..	..	6,430	..	Lg. 7. & 2. or 5., pr. 2½.	Max. demand & flat rate	..	..	..	..	Prepayment meters, rate 6d.	80
0 arc, 160 inc. 1 Nernst	3=3 H.P. ..	..	6,610	37	Lg. 7. & 4. or 6., pr. 4. & 1½. or 2½."	Max. demand & flat rate	76,357	3.38	2.04	3	" Pb. lg. £440 p.a.	81
8 arc, 150 inc.	192 H.P. ..	980 H.P. ..	46,054	..	Lg. 4½., pr. 3., tr. 1¼., pb. lg. 3.	Flat rate ..	618,104	2.36	.94"	1.185	Lg. and tr. " Pb. lg. charged to Highways Committee	82
9 arc, 370 Nernst	218=1,120¾ H.P.	..	106,790	22.44	Lg. 6. & 3. & 5½. to 4., pr. 3. 2. & 1.	Max. demand & sl. scale	1,490,611	3.37	..	..	Pb. lg., arcs, 2d. per lamp hr., inc. 2d. p.u.	83
0 arc, 1 inc.	13=161½ H.P.	76=1,900 H.P.	62,398	..	7. & 3. or 5., pr. 2½., tr. 3. & 1¼. or 2."	Flat rate & max. demand	1,349,645	2.232	.865	1.09	Power supplied to Tram Cos. " Pb. lg. £22½ per lamp, p.a.	84
1 arc, 32 inc.	49=206 H.P.	..	24,248	15	Lg. 6. & 3½., pr. 4. & 1.	Max. demand	784,124	2.62	.93	1.28	Lg. and tr. Supply to B. E. T. Co. ..	85
..	5=8 H.P. ..	..	1,360	..	Lg. 8. & 6., pr. 4. & 1. tr. 1.5.	Max. demand & flat	..	..	..	..	Lg. and tr.	86
arc ..	266 H.P. ..	1,300 H.P. ..	64,870	29	Lg. 5., 4½. & 3., pb. lg. 3., pr. 2., tr. 1½.	Max. demand & flat rate	859,919	2.54	.9	1.17	Lg. and tr.	87
0 arc, 147 inc.	43=347 H.P.	34=850 H.P.	57,325	13	Lg. 7. & 3., or 6. w. dia., tr. 2½., pr. 2½."	Max. demand & flat rate	980,717	3.33	1.57	2.95	Lg. and tr. Data to Dec. 31st 1903. " Pb. lg. arc £30 p.a., inc. 2½ p.u.	88
00 arc ..	60	..	..	..	Lg. 7. & 2½., pb. lg. £22½ p.a. pr. 7. & 1.	Max. demand	..	..	..	..	.. ..	89
5 arc, 260 inc.	34=178½ H.P.	..	26,634"	31	6. & 1½., pr. 6 & 1½., pb. lg. £20 & 2. tr. 2. to 1.	2-rate meter, sc. & flat rate	1,526,713	..	..	..	Lg. and tr. " Tr. not included.. ..	90
1 arc ..	158=444 H.P.	120=3,960 H.P.	179,300	8.5	Lg. 4., pr. 2., tr. 1½., pb. lg. £15	Flat rate with disc.	2,868,566	2.278	1.244	1.516	Lg. and tr.	91
..	..	..	..	..	7. & 2½.	Max. demand	..	..	..	..	.. ..	92
4 arc, 1,354 inc. (8 c.p.)	28=100 H.P.	..	72,342	40	Lg. 6. or 8. & 3., pr. 3. & 2½.	Flat rate & max. dem.	1,061,310	5.56	1.64	2.03	Pb. lg. £21½ and £1.36	93
0 arc ..	32=58 H.P.	..	64,898	16	Lg. 6.. r. 2½., pb. lg. £22 p.a.	Flat rate ..	897,193	5.5	1.66	2.20	Condensing plant to be erected. Destructor ready about July, 1904	94
71 arc, 137 inc.	24=64 H.P.	70=1,750 H.P.	74,644	..	Lg. 6. & 2. or 4½., pr. 2½., tr. 2."	Max. demand & flat rate	1,843,880	..	1.11	1.44	Lg. and tr. Data to March 31st, 1903	95
arc, 426 inc.	2=6 H.P. ..	..	10,980	..	7. & 2., or 6. to 4.	Max. demand & flat rate	..	..	..	..	"Pb. lg. arc £18, inc. 4 5-16 Traction contemplated	96
96 arc ..	1,215=5,219 H.P.	..	671,459	19.3	Lg. 3½., pr. 1½., pb. lg. £11	Flat rate with discount	9,039,112	Lg. 3.34; pr. 1.19; pb. 2.05	.65	1.07	1,200 H.P. set being erected	97
2 arc, 276 inc. 24 Nernst	2=16 H.P. ..	..	6,362	..	Lg. 6¾., pr. 3." ..	Flat rate ..	109,550	..	..	..	" Arc £17½, N. £5, inc. £3½	98
8 arc, 644 Nernst.	2=12½ H.P. ..	..	6,000	..	Lg. 7. & 3. or 5., pr. 3. & 1½.	Max. demand & flat rate	..	..	..	..	.. ..	99
3 arc ..	12=40 H.P. ..	..	27,500	.	Lg. 6. to 4., pr. 3.	Sliding scale & flat rate	..	..	..	..	.. ..	100
1 arc, 82 inc. 16 Nernst	7=15 H.P. ..	..	4,420	..	Lg. 4½., pr. 2., pb. lg. £16½ per arc.	Flat rate with discount	..	..	..	..	.. ..	101
7 arc, 109 inc.	..	..	3,760	..	7.	Flat rate ..	..	..	..	..	.. ..	102
33 arc, 136 inc.	388½ H.P. ..	24=600 H.P.	34,345	23	Lg. 7. & 3. or 5., pr. 2½. to 1., tr. 5."	Max. demand, flat & scale	628,032	1.45	.64	.84	Lg. and tr. Supply part of Kearsley. " Arc £16 p.a.	103
..	..	..	..	..	Lg. 6., pr. 3. ..	Flat rate with rebates	..	..	..	..	.. ..	104
5 arc ..	10=12 H.P.	..	7,765	..	Lg. 8., pb. lg. 4½. to 2., pr. 6. to 4.	Flat rate & scale	..	..	..	..	.. ..	105
3 arc, 600 inc.	63 H.P. ..	..	11,000	..	Lg. 6., pr. 3.	Flat rate ..	..	..	..	..	.. ..	106
5 arc, 132 inc.	19=73 H.P. ..	..	54,805	..	Lg. 7., 4., & 2., or 6., pr. 7. & 1.	Max. demand & flat rate	745,510	4.5	1.93	2.54	2,750 v., D.C. feeders. Supply to Sandgate and Hythe	107
arc, 60 inc.	2=4 H.P. ..	..	6,300	2½	Lg. 6¾., pr. 1. pb. lg contract	Flat rate ..	..	..	..	..	.. ..	108
arc, 4 inc...	8=8.5 H.P. ..	..	4,000	..	Lg. 5., pr. 3. ..	Flat rate ..	68,641	4½	1½	3	Water chief source of supply .. .	109
..	..	..	..	..	Lg. 7. & 2½., pr. 4. & 1½.	Max. demand & 2-rate meter	..	..	..	..	Lg. and tr.	110
..	..	..	10,103	30	Lg. 7. & 2. or 4½., pb. lg. 2½., pr. 1½.	Max. demand & flat rate	117,976	..	..	..	.. ..	111
18 arc ..	427=1894 H.P.	..	630,708	28.35	Lg. 6. & 1. or 3½., pb. lg. arc £14 p.a. pr. 1½. to ¾. m.d.	Max. demand, flat rate & contract	11,501,824	2.65	.88	1.06	Three stations	112
..	..	..	..	..	Lg. 7. & 4., pr. 4. & 1½.	Max. demand	..	..	..	..	.. ..	113
4 arc, 4 Nernst	13=32 H.P. ..	..	22,000	..	Lg. 6. & 2., pr. 3. & 1½.	Max. demand	..	..	..	..	.. ..	114
43	11=22 H.P.	..	11,801	..	Lg. 7. & 4. or 6., pr. 4 & 1½, htg. 2½.	Max. demand, flat, contract	148,592	3.74	1.9	1.75	.. ..	115
12 inc. ..	..	..	1,320	14	6. & 4., or 1/3 per c.p. p.a.	Max. demand or contract	..	..	..	..	.. ..	116
00 arc (extending)	650 H.P. ..	..	42,975	..	Lg. 6. & 1. or 4.,3½. & 3., £17 arc, pr. 2—1.	Max. demand contract, scale	896,100	2.16	.672	1.03	Data to Mar. 15th, 1904, units to May, 1904	117
..	4=20 H.P. ..	..	18,730	..	Lg. 7. & 3., pr. 4. & 1. or 2½.	Max. demand & flat rate	119,784"	4.1	.88	1.17	Small houses free-wired, 7d. p. u. slot meter. "10 months only	118
7 arc ..	..	..	..	..	Lg. 7. & 3., pr. 3. ..	Max. demand	..	..	..	..	Lighting and traction (Gravesend and Northfleet Tramway Co.).	119
04 inc., 20 Nernst	9=27 H.P. ..	..	7,695	33	Lg. 7. & 4., pr. 2½., pb. lg. 3½.	Max. demand, flat & contract	188,820	4.33	1.83	2.63	.. ..	120
arc, 3 Nernst	77=758 H.P.	60=1,500 H.P.	80,863	16.8	Lg. 6. & 2. or 4½., pr. 2½. to 1½., tr. 1½.	Max. demand, flat & scale	1,263,972	2.3	1.01	1.31	Traction supply (250 KW.) to G. & Port Glasgow Ty. Co. over 500,000 units 7-10d.	121
0 arc ..	41=167 H.P.	M.D. 22 KW.	31,812	..	Lg. 4½., pr. 2½. to 1½. & 1 t. sw., tr. 1½. to 1¼.	Flat rate, cont., scale & t. sw.	653,438	2.51	.99	1.4	Energy supplied to Tramway Co. Pb. lg. arc £20 p.a.	122
2 inc. ..	74=770½ H.P.	..	47,518	63.2	Lg. 7. & 3. or 6., pr. 4. & 1½. or 2½., htg. 2.	Max. demand & flat	434,958	2.97	1.59	1.97	Data to Dec. 1903. New station nearly completed. Pb. lg. inc. £2½ p.a.	123
arc, 3 Nernst	28=89 H.P.	..	17,092	70	Lg. 6., pr. 3. to 2., pb. lg. 3.	Flat rate & scale	145,891	6.1"	2.6	3.48	"includes meter rents	124

107	FOLKESTONE	F. Electric Supply Co.	1898	T. Hesketh	210	Direct	4 Economic (oil burnt in two), 1 B. & W., suphtr., cond.	6 Peache
108	FORT WILLIAM	Fort W. Electric Lighting Co.	1896	I. Reid	150 D.C., 300 A.C.	Direct & altg.		3 Gilkes turbines a
109	GALWAY	Galway Electric Co.	1889	James Perry	110	Direct	1 Dowson gas producer plant	2 Hercules water tu gas engine
110	GATESHEAD	County of Durham E. P. D. Co.	1901	A. S. Esslemont	230, 460 & 500	Direct and altg.—50	8 B. & W., suphtrs. and stokers	5 Brush and Bellis
111	GILLINGHAM	Corporation	1897	A. D. Chalmers	100 & 200	50—, 3-ph.	3 B. & W.	3 Willans
112	GLASGOW	Corporation	1892	W. A. Chamen	250&500 d.c., 6,500 a.c.	25—, 2-ph. & direct	18 B. & W.	9 Willans, 4 Belliss, Wood, 2 Mirrlees & MacLellan
113	GLOSSOP	Urban Electric Supply Co.	1902	C. E. Knowles	240 & 480	Direct	2 Economic	3 Belliss
114	GLOUCESTER	Corporation	1900	W. J. Bache	220 & 440	Direct	4 Lanc., stokers, econ.	2 Belliss, 1 Willans
115	GODALMING	Urban Electric Supply Co.	1902	R. S. Robertson	240	Direct	3 B. & W., chain grates, Boby feed heater	3 Belliss
116	GORSEINON	Gorseinon Electric Light Co.	1894	D. Powell	200	Direct	1 Cornish (Harvey)	1 Thos. White, 1 Pe
117	GOVAN	Corporation	1900	T. C. Parsons	250 & 500	Direct	5 B. & W.	4 Belliss, 1 Browett
118	GRANTHAM	Urban Electric Supply Co.	1903	W. E. Milns	240 & 480	Direct	3 Hornsby, suphtr., Boby feed heater	3 Belliss
119	GRAVESEND	Corporation	1902	C. F. McInnes	230	Direct	3 B. & W., stokers, econ. and detart.	3 Alley & Maclellan
120	GRAYS THURROCK	Urban District Council	1901	E. D. Long	230 & 460	Direct	2 Lanc., Meldrum destructor and Lanc. blr., 2 cells	2 Reavell
121	GREENOCK	Corporation	1899	J. A. Robertson	250 & 500	Direct	6 B. & W., stokers, econ., cond.	7 Belliss
122	GRIMSBY	Corporation	1901	W. A. Vignoles	230 & 460	Direct	4 Lanc., 1 Stirling, econ., cond. clg. tr.	8 Belliss
123	GUERNSEY	Guernsey Electricity Supply Co.	1900	A. G. Bird	210 & 420	Direct	4 B. & W., econ.	4 Belliss
124	GUILDFORD	Guildford Electricity Supply Co.	1896	H. L. Alderton	215	Direct	3 B. & W., stokers, cond.	6 Willans, 1 Diesel
125	HALIFAX	Corporation	1894	W. M. Rogerson	230	Direct	6 B. & W., stokers, econ.	3 Belliss, 3 Pollit, 2
126	HAMILTON	Corporation	1903	T. M. Colson	240 & 480	Direct	3 Bow	3 Belliss
127	HANLEY	Corporation	1894	C. A. Cowell	100 & 200	100—, 1-ph.	8 Lanc., econ.	6 Brush, 2 Ferranti
128	HARRINGTON	H. Electric Light Co.	1897	W. Collins	115	Direct	3 Lanc.	2 Browett-Lindley, Willans
129	HARROGATE	Corporation	1897	G. Wilkinson	100 & 200	50—, 1-ph.	5 Lanc., stokers, econ., suphtrs.	4 McLaren, 1 Parson
130	HARROW	H. Electric Light & Power Co.	1896	E. R. Hill	220 & 440	Direct	4 B. & W., econ.	6 Willans
131	HASTINGS	Corporation	1882	R. F. Ferguson	200 & 400	100—, 1-ph.	5 B. & W., econ., cond. clg. tr.	3 Brush, 2 Belliss, bine, 1 Paxman Pe
132	HAWICK	Urban Electric Supply Co.	1902	A. N. Rye	240 & 480	Direct	3 B. & W.	3 Belliss
133	HEBBURN	Northern Counties Elec. Supply Co.	1903	C. S. Vesey Brown C. W. Fairweather	230 & 460	Direct	2 B. & W.	2 Allen
134	HECKMONDWIKE	Urban District Council	1901	G. H. Carter	230 & 460	Direct	2 water tube	2 Reavell, 2 Howden
135	HEREFORD	Corporation	1899	F. G. Poulton	220 & 440	Direct	2 Lanc., econ., cond.	3 Belliss
136	HEYWOOD	Corporation	1900	Jas. Stott	200 & 400	Direct	2 Lanc., econ.	2 Reavell
137	HICH BARNET	North Metropolitan E. P. D. Co.	1900	J. M. Bowman	230 & 460	Direct	1 B. & W., 2 Tinker	2 Reavell, 2 Brush
138	HICH WYCOMBE	Wycombe (Borough) E. L. & P. Co.	1898	W. E. Brandreth	210 & 420	Direct	4 Paxman Economic, feed htr., 1 B. & W., fired suphtr., cond.	4 Peache, 1 Belliss
139	HORNSEY	Corporation	1903	N. Staniland	240	Direct	3 marine	2 Browett-Lindley
140	HOVE	Hove Electric Lighting Co.	1892	C. B. Smith	220	Direct	2 Lanc., 7 B. & W., econ.	11 Willans, 1 Belliss
141	HOYLAKE & W. KIRBY	Urban District Council	1901	H. G. M Haffie	230	50—, 1-ph.	3 Lanc., econ., suphtr.	4 Belliss
142	HUDDERSFIELD	Corporation	1893	A. B. Mountain	100 & 200	100—, 1-ph.	11 Lanc., 6 B. & W., stokers and econ.	4 Brush, 3 McLaren,
143	HULL	Corporation	1893	H. Bell	220 & 440	Direct	14 Lanc.	6 Willans, 6 Allen, 2
144	ILFORD	Urban District Council	1901	A. H. Shaw	230 & 460 & 500 tr.	Direct	4 B. & W., 2 Fraser marine, suphtrs., econ.	5 Willans
145	ILKESTON	Corporation	1903		230 & 460	Direct	Bulk supply from	Derby and
146	INCLETON	I. Electric Lighting & Power Co.	1900	D. Tattersall	100 & 200	Direct		2 Gilkes "Vortex" t
147	IPSWICH	Corporation	1903	W. F. Ayton	230 & 460	Direct	4 Danks dryback, Meldrum dest., 4 cells	4 Reavell
148	JARROW	County of Durham El. Pr. Dist. Co.	1902	W. E. Tooth	230 & 460		2 B. & W. marine, 1 Fraser dryback	4 Universal
149	KEIGHLEY	Corporation	1901	J. M. Smyth	230 & 460	Direct	2 Lanc., stokers, econ., cond.	3 Allen
150	KENDAL	Corporation	1902	W. Thomson	220 & 440	Direct	2 Dryback	2 Willans
151	KESWICK	K. Electric Light Co.	1890		100	75—, 1-ph.	1 Lanc.	1 Westinghouse, 1 V
152	KETTERING	Urban District Council	1904	F. J. Bakewell	230	Direct	3 Lanc., econ. 1 Lanc. with 2-cell Meldrum dest.	4 Willans
153	KIDDERMINSTER	K. and Dist. Elec. Ltg. and Tr. Co.	1900	W. Griffiths	230 & 460	Direct	5 B. & W., econ.	3 Brush, 2 Parsons t
154	KILLARNEY	Killarney Electric Lighting Co.	1893	L. C. Trevor-Roper	100	100—, 1-ph	1 loco-type, cond.	1 Fowler, 1 turbine,
155	KING'S LYNN	Corporation	1899	J. Pilling	200 & 400	Direct	2 Lanc., econ., cond., 2 vert. for producer plant	2 Belliss (steam), 5 (gas)
156	KIRKCALDY	Corporation	1903	O. F. Francis	230	Direct	3 Stirling	6 Browett-Lindley
157	KINGSTON-UPON-THAMES	Corporation	1893	J. E. Edgcome	105	77—, 1-ph.	3 Lanc., 4 B. & W., stokers, suphtrs., cond., econ.	11 Belliss
158	LANCASTER	Corporation	1894	W. A. Tester	100 & 200	Direct	5 Lanc., 2 Lancs. & destructor	4 Willans, 1 Westing
159	LARNE	Larne Electric Lighting Works	1891	M. G. Smyth	100 & 200	100—, 1-ph.	2 Cornish, induced draught	2 Combe Barbour, 1
160	LEAMINGTON	Midland Elec. Light & Power Co.	1887	F. W. E. Jones	115 & 230	Direct	3 Robey loco., cond.	3 Robey, 1 Belliss
161	LEATHERHEAD	L. & District Electric Supply Co.	1902	H. W. Petty	220	Direct	2 Paxman	2 "Vauxhall-Rossiter
162	LEEDS	Corporation	1893	H. Dickinson	100, 200 & 400	83—, 1-ph., 50—, 2-ph.	14 Lanc., 12 B. & W., stokers, econ., suphtrs. and cond.	1 Fowler, 2 Hick-H Belliss, 1 McLaren
163	LEICESTER	Corporation	1894	A. Colson	100 & 200	50—, 1-ph.	6 B. & W., 5 Lanc.	6 Hick Hargreaves
164	LEICH	Corporation	1899	D. M. Kinghorn	220 & 440	Direct	1 Lanc., 2 water tube	2 Willans, 1 Gallowa
165	LEITH	Corporation	1899	A. P. Rutherford	230 & 460	Direct	6 Lanc., econ.	Platt h.s. 7 Belliss, 2 Howden
166	LEWES	Lewes & District Electric Supply Co.	1901	W. F. Bolton	230 & 460	Direct	3 B. & W., suphtrs, cond., feed htr.	2 Brush, 1 Allen
167	LEYTON	Urban District Council	1896	F. H. Lewis	150 & 300	Direct	8 Paxman. econ.	6 Willans
168	LIMAVADY	Limavady Power and Light Works	1897	E. J. S. Ritter	110 & 220	100—, 1-ph.		Turbines
169	LIMERICK	Corporation	1902		230 & 460	Direct		3 Westinghouse gas e
170	LINCOLN	Corporation	1898	S. Clegg	230 & 460	Direct	5 Marine, econ., 1 Climax	6 Willans, 1 Howden
171	LIVERPOOL	Corporation	1883	A. Clough (Res.)	230 & 460	Direct	87 Lanc., stokers, econ.	75 Willans
172	LIVERPOOL DISTRICT	Liverpool District Lighting Co.	1897	W. M. Horsfall	220	Direct	3 Lanc., stokers, feed htr.	4 Willans, 2 Browett-
173	LLANDILO	Urban District Council	1902		230 (2-wire)	Direct	1 Cornish	1 Browett-Lindley
174	LLANDRINDOD WELLS	L. W. Electric Light & Power Co.	1897	A. H. Sears	230 & 460	Direct	3 Lanc.	1 Willans, 1 Alley & Reavell
175	LLANDUDNO	Urban District Council	1898	H. Morton	220 & 440	Direct	6 B. & W. (2 with Beaman & Deas destructor, 4 cells), econ.	3 Belliss, 3 Allen
176	LONDONDERRY	Corporation	1894	R. V. Macrory	2,150 to 2,500	Direct	2 Lanc., econ., cond. 4 Lanc.‡	3 Brown & Sons, 4 Al
177	LONG EATON	Urban District Council	1903	F. Worrall	220	Direct	2 Lanc.	2 Browett-Lindley
178	LONGTON	Corporation	1901	W. Langford	230	Direct	2 B. & W., econ.	2 Belliss
179	LOWESTOFT	Corporation	1901	G. A. Bruce	230 & 460	Direct	4 B. & W., suphtrs., cond., 1 Musgrave	3 Musgrave, 7 Brow Willans
180	LUTON	Corporation	1901	W. H. Cooke	250 & 500	Direct	2 Lanc., cond., econ., suphtr., water softener	4 Allen
181	LYMINGTON	L. Electric Light & Power Co.	1900	Glynn Salter	240	Direct	2 B. & W., suphtrs.	2 Belliss
182	LYNTON & LYNMOUTH	Lynton & Lynmouth E. L. Co.	1890	P. T. Kimmins	100	100—, 1-ph.	1 loco.	1 Sharman (steam), 1
183	MACROOM	M. & District Elec. Ltg. Syndicate	1899	D. E. McDonnell	230	100—, 1-ph.	1 Cornish	3 Pelton (water) 1 water turbine, 1 w
184	MAIDSTONE	Corporation	1901	E. E. Hoadley	230 & 460	Direct	4 Paxman dryback	Brush 5 Peache

6 Peache	6 Parker	1,000	624	Tudor, max. dis. 2 KW.	Callender fdrs. tri. conc.; dist. 3-core		£138,8
3 Gilkes turbines and oil engine	2 Laurence Scott, 1 General Electric	120	190	E. P. S. max. dis. 30 KW.	Overhead, and underground, Glover dia. armd.		£11,0
2 Hercules water turbines, 1 Crossley gas engine	3 Statter, 2 Crompton, 1 Holmes, geared	153	84	Tudor, 24 KW. for 3 hrs.	Bare copper and diatrine single in bitumen		£10,0
5 Brush and Belliss	7 Brown Bostri, Brush, Siemens & Halske (D.C. 2,100 KW., A.C. 750 KW.)	2,850	..	Pollak, traction; Hart, lighting	Callender, fdrs., tri. conc.; dist., 3-core, solid in wood troughs		..
3 Willans	3 B. T. H.	550	170	.. ..	Henley, fdrs. 3-core, dist. 4-core		..
9 Willans, 4 Belliss, 1 Paul, 1 Ball & Wood, 2 Mirrlees Watson, 1 Alley & MacLellan	7 Crompton, 2 Westinghouse, 3 Peebles, 2 Walker, 2 Schuckert, 2 B. T. H., 2 Brit. Elec. Plant	10,443	9,371	Tudor, max. dis. 840 KW.	Callender and B. I. twin conc. fdrs., triple conc. and conc. dist.		£1,041.7
3 Belliss	3 Parker	..	..	D. P., 400 amp.-hrs.	Callender single, laid solid		..
2 Belliss, 1 Willans	4 Silvertown, 2 Mather & Platt	750	304	E. P. S., 1,000 amp.-hrs.	Callender, triple conc., solid		£59,0
3 Belliss	3 Fowler	380	133	D. P., max. dis. 90 KW.	Callender v. bit. solid, in wood trough, for public lamps 3-core lead covd. and armd.		..
1 Thos. White, 1 Powis	1 Elwell Parker, 1 E. C. C.	60	32	.. ..	Overhead 2-wire, Henley, vulcanized rubber		£1,8
4 Belliss, 1 Browett Lindley	2 B. T. H., 1 Silvertown, 1 Dick Kerr, 1 L. D. & M.	1,200	600	Tudor, max. dis. 200 KW.	Callender & Glover, single lead covd. and armd.		£65,0
3 Belliss	3 Parker	380	156	D. P., max. dis. 68 KW.	Callender 3-way solid and 3-core armd., v. bit.		£47,8
3 Alley & Maclellan	3 Lancashire Dynamo Co.	600	..	Pritchetts, 500 amp.-hrs.	Western Electric lead covd., ppr., solid		£35,6
2 Reavell	2 British Schuckert	200	100	D.P., max. dis 60 KW.	Callender, triple conc. bit. armd. direct, and 3-core for st. ltg.		£18,6
7 Belliss	8 Silvertown	1,400	796	Tudor, 140 KW. normal dis.	Callender, vulc. bit., solid and in C.W. casing		£40,1
8 Belliss	8 Mather & Platt, 2 Westinghouse	900	..	Tudor, max. dis. 125 KW.	Fdrs. B.I. and Anchor, conc., paper, lead covd., solid, dist. B.I., J. & P. and Anchor, triple conc.		£72,4
4 Belliss	4 Parker	510	368	D. P., max. dis. 150 KW.; Tudor, max. dis. 336 KW.	Callender, fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid		£108,4
6 Willans, 1 Diesel (oil)	3 Jackson, 2 Rosling, 2 Taunton	430	192	Niblett, max. dis. 45 KW.	Callender, v. bit. and fibre, iron armd.		£37,4
3 Belliss, 3 Pollit, 2 Parsons turbines	6 E. C. C., 2 Parsons	4,750	2,299	Chloride, 400 amp.-hrs.	B.I. & H. and Callender, paper and bit.		£212,4
3 Belliss	3 Parker	380	174	Tudor, max. dis. 150 KW.	Calleader. v. bit., single, wood troughing, solid		..
6 Brush, 2 Ferranti	4 Mordey, 2 Ferranti A.C., 2 Brush arc	1,224	775	.. ..	V. r. conc., ppr., Callender, Glover and B.I. & H.		£83,4
2 Browett-Lindley, 1 Tangye, 1 Willans	3 Holmes, 1 Parker	210	120	.. ..	J. & P., twin, solid		..
4 McLaren, 1 Parsons turbine	3 Ferranti, 1 Siemens, 1 Parsons	1,150	660	.. ..	B.I & H. and Siemens, conc., ppr., lead covd.		£92,4
6 Willans	4 Crompton, 1 Mather & Platt, 1 Siemens	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid		£56,4
3 Brush, 2 Belliss, 1 Parsons turbine, 1 Paxman Peache	5 Brush, 1 Parsons, 1 Crompton	1,235	610	Tudor, max. dis. 15 KW.	Glover, paper, diatrine		£131,4
3 Belliss	3 Parker	380	200	D. P., max. dis. 50 KW.	Callender, vulc. bit. single, laid solid in wood trough		£47,4
2 Allen	2 Crompton	400	..	Chloride, 500 amp.-hrs.	Callender, single, laid solid		..
2 Reavell, 2 Howden	2 Fowler, 2 Dick Kerr	650	497	Tudor, max. dis. 100 KW.; Chloride, max. dis. 150 KW.	Henley, fdrs. tri. conc. solid; dist. 3 single, solid		£20,4
3 Belliss	3 Silvertown	450	158	Chloride, max. dis. 50 KW.	Silvertown, v. r. in bit., solid, single		£22,4
2 Reavell	2 Crompton	120	41	Marquand, 300 amp.-hrs.	V. bit. and ppr., lead covd., solid		£1,4
2 Reavell, 2 Brush	2 Holmes, 2 Brush	300	144	Hart, max. dis. 38 KW.	Callender, fdrs. tri. conc., armd.; dist. 3-core, armd. laid direct		
4 Peache, 1 Belliss	5 Parker	830	380	Tudor, max. dis. 120 KW.	Callender, fdrs. tri. conc., dist. 3-core, all armd. direct		£8,4
2 Browett-Lindley	2 Mather & Platt	600	310	E. P. S., max. dis. 250 KW.	Siemens, triple conc., ppr., lead covd. armd. & laid solid		£7,4
11 Willans, 1 Belliss	14 Crompton	1,383	798	Tudor, max. dis. 40 KW.	Bare cpr. in ducts, insd. cable in iron pipes		£14,4
4 Belliss	4 Crompton	375	198	Chloride, 300 amp.-hrs.	Callender, fibre, conc. lead covd., solid		£4,4
4 Brush, 3 McLaren, 1 Ferranti	4 Brush, 2 Ferranti, 2 Siemens	3,200	1,564	.. ..	B.I. & H. armd. conc., and Glover fdrs., conc. armd. dist., in troughs		£16,4
6 Willans, 6 Allen, 2 Browett-Lindley	2 Holmes, 12 Parker	4,454	3,090	Pritchetts, 438 KW. hrs.	Siemens, Callender, fdrs.. conc., jute sheathed; dist. v. bit., lead covd. and armd., and Crompton		£28,4
5 Willans	3 G. E. C., 2 Dick Kerr	1,600	Ltg. 832, tr. 250	E. P. S., max. dis. 100 KW.	Henley, conc. paper, lead covd., armd.		£11,4
Derby and Notts. Electric Power Co.		..	..	.. ..	Callender, laid solid		
2 Gilkes "Vortex" turbines	2 J. P. Hall	21	21	D. P., max. dis. 15 KW. for 9 hrs.	Callender, fdrs., tri. conc., dist. 3-core., armd., direct		£
4 Reavell	4 A. E. G.	330	..	Tudor, 400 amp.-hrs.	Johnson & Phillips, ppr., lead covd., solid in wood		£6,4
4 Universal	4 Brush	300	66	420 amp.-hrs., 280 amp. max.	Fdrs. triple conc., dist. 3-core, solid		
3 Allen	3 Parker	440	120	Tudor, 35 KW. for 10 hrs.	Callender, jute, lead covd., & vulc. bit., single, solid		£
2 Willans	2 Johnson & Phillips	72	64	Tudor, max. dis. 90 amp. for ½ hr.	B.I. & H., triple conc., 2 and 3-core		£
1 Westinghouse, 1 Victor turbine	2 Kapp	60	..	.. ..	V. r. underground and overhead		
4 Willans	4 Parker	480	..	E. P. S., 360 amp.-hrs.	Glover, ppr. ins., lead covd., conc.		
3 Brush, 2 Parsons turbines	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	B.I. & H., armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid		
1 Fowler, 1 turbine, 1 water-wheel	2 Mordey, 1 Ferranti	160	82	.. ..	Callender, armd. conc. fdrs., lead covd. conc. dist.		
2 Belliss (steam), 5 Fielding & Platt (gas)	2 Laurence Scott, 5 G. E. C.	520	290	Chloride, 157 KW. max. dis.	Siemens, Callender, B.I.H., triple conc.		£
6 Browett-Lindley	8 Laurence Scott	1,090	175 lg., 300 tr.	Tudor, max. dis. 184 KW.	Henley, single lead covd., ppr., solid in wood		£
11 Belliss	11 Siemens	660	425	.. ..	Siemens, Glover, Henley, B.I. & H., armd. conc. laid direct		£
4 Willans, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	660	.. ..	Callender		£
2 Combe Barbour, 1 Belliss	2 Brush, 1 B.T.H.	150	64	.. ..	B.I. & H. fdrs. conc., paper; dist. bare copper, overhead		
3 Robey, 1 Belliss	5 Chamberlain & Hookham, 1 E.C.C.	590	204	E. P. S., max. dis. 290 KW.	Callender, jute, lead covd., fdrs. armd., dist. bit. solid		
2 "Vauxhall-Rossiter"	2 Lancs. D. & M. Co.	80	37	Tudor, 72 KW. for 3 hrs.	Glover, laid solid, Howard troughing		
1 Fowler, 2 Hick-Hargreaves, 12 Belliss, 1 McLaren	4 Ferranti, 9 E. C. C., 3 Fowler	8,740	5,040	.. ..	B.I. & H., Henley and Silvertown, paper		£
6 Hick Hargreaves	4 Ganz, 2 Brush	3,400	2,036	.. ..	B.I. & H., paper conc.		£
2 Willans, 1 Galloway, 1 Mather & Platt h.s.	5 Mather & Platt	410	270	Chloride, max. dis. 140 KW.	B.I. & H., Johnson & Phillips, and Anchor Cable Co., triple conc., lead covd., solid, and diat.		
7 Belliss, 2 Howden	7 Silvertown, 2 Crompton	1,600	925	E. P. S., max. dis. 300 KW.	Triple conc., ppr., direct with steel plates, and solid in wood, B.I. & H.		
2 Brush, 1 Allen	3 Brush	210	94	Hart, max. dis. 14 KW.	Western Electric, fdrs. tri. conc., paper, dist. 3-core		
6 Willans	5 Mather & Platt, 1 A. E. G.	1,572	854	Tudor, max. dis. 250 KW.	Armd. conc., also lead covd. in ducts for dist.		£
Turbines	4 Siemens	240	35	.. ..	Bare copper, overhead		
3 Westinghouse gas engines	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid.		
6 Willans, 1 Howden	7 Laurence Scott, 1 Bruce Peebles	1,018	372	Chloride, 300 amp.-hrs.	Callender, fdrs., conc., armd., dist., conc. and triple conc., v. bit. armd.		
75 Willans	75 Siemens	21,695	12,600	E. P. S.	Callender solid.		£1
4 Willans, 2 Browett-Lindley	4 Parker, 1 Siemens, 1 Robinson	435	264	E. P. S., max. dis. 116 KW.	Callender, fdrs. 3 wire, dist. 2 wire, solid		
1 Browett-Lindley	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct		
1 Willans, 1 Alley & MacLellan, 1 Reavell	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	260	..	.. ..	Glover conc. and single, B.I. & Helsby 2-core, armd. direct		
3 Belliss, 3 Allen	4 Silvertown, 2 Crompton	700	460	Pritchetts & Gold, max. dis. 26 KW.	Henley, Glover, and B. I. & H., triple conc. fdrs., 3-core dist. armd., lead cov., direct		
3 Brown & Sons, 4 Allen‡	6 Siemens arc, 4 B. T. H.‡	180 700‡	101	E. P. ‡, max. dis. 670 KW.‡	W. E. Co., paper, lead covd., conc., fdrs. conduit, dist. solid		
2 Browett-Lindley	4 Lancs. D. & M. Co.	200	192	.. ..	B.I. & H., lead covd., fdrs. tri. conc., solid: dist., tri. conc., armd. direct		
2 Belliss	2 E. C. C.	300	69	Chloride 40 KW. for 13 hrs.	Callender, vulc. bitumen, solid		
3 Musgrave, 7 Browett-Lindley, 5 Willans	12 B. T. H., 3 Lanc. Dynamo Co.	1,475	550	.. ..	Callender fdrs. armd., dist. v. bit laid solid		
4 Allen	5 Allen	297	128	Chloride, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core Dialite v. b.		
2 Belliss	2 Parker	124	69	D. P., max. dis. 22 KW.	Callender, triple conc. fdrs., 3-core dist., all armd.		
1 Sherman (steam), 1 Escher Wyss, 3 Leffel (water)	2 Brush, 1 E. C. C.	150	60	.. ..	Fdrs. 2-core, paper, dist. single, paper, Glover & Callender		
1 water turbine, 1 water wheel, 1 Brush	1 B. T. H., 1 Brush, 1 Ediswan	150	47	.. ..	Glover conc. lead covd. and armd.		
5 Peache	3 Parker, 2 Westinghouse	750	351	Chloride, max. dis. 150 KW.	Callender, single, solid in iron trg.	£50,000	20,000

..	1,000	624	Tudor, max. dis. 2 KW. ..	Callender fdrs. tri. conc.; dist. 3-core	£138,827	..	66 arc, 132 inc.	19=73 H.P...	..	54,805
ic	120	190	E. P. S. max. dis. 30 KW. ..	Overhead, and underground, Glover dia. armd... ..	£11,091	6,000	6 arc, 60 inc.	2=4 H.P. ..	..	6,300
s,	153	84	Tudor, 24 KW. for 3 hrs. ..	Bare copper and diatrine single in bitumen	£10,000	3,654	8 arc, 4 inc...	8=8.5 H.P. ..	..	4,000
&	2,850	..	Pollak, traction; Hart, lighting	Callender, fdrs., tri. conc.; dist., 3-core, solid in wood troughs	..	..	..	..	..	..
.)	550	170	.. ..	Henley, fdrs. 3-core, dist. 4-core	..	..	..	..	..	10,100
3	10,443	9,371	Tudor, max. dis. 840 KW. ..	Callender and B. I. twin conc. fdrs., triple conc. and conc. dist.	£1,041,746	494,943	348 arc ..	427=1894 H.P.	..	630,708
t,										
..	..	..	D. P., 400 amp.-hrs.	Callender single, laid solid	..	..	..	..	..	..
..	750	304	E. P. S., 1,000 amp.-hrs. ..	Callender, triple conc., solid	£59,047	20,400	54 arc, 4 Nernst	13=32 H.P...	..	22,000
..	380	133	D. P., max. dis. 90 KW. ..	Callender, v. bit. solid, in wood trough, for public lamps 3-core lead covd. and armd.	..	9,900	943	11=22 H.P.	..	11,801
..	60	32	.. ..	Overhead 2-wire, Henley, vulcanized rubber	£1,400	1,200	112 inc. ..	..	..	1,320
ek	1,300	600	Tudor, max. dis. 200 KW. ..	Callender & Glover, single lead covd. and armd. ..	£65,000	24,122	100 arc (extending) ..	650 H.P. ..	..	42,975
..	380	156	D. P., max. dis. 68 KW. ..	Callender 3-way solid and 3-core armd., v. bit. ..	£47,580	13,730	..	4=20 H.P. ..	..	18,730
..	600	..	Pritchetts, 500 amp.-hrs. ..	Western Electric lead covd., ppr., solid	£35,000	..	27 arc ..	..	..	..
..	200	100	D.P., max. dis 60 KW. ..	Callender, triple conc. bit. armd. direct, and 3-core for st. ltg.	£18,600	6,457	404 inc., 20 Nernst	9=27 H.P. ..	..	7,695
..	1,400	796	Tudor, 140 KW. normal dis...	Callender, vulc. bit., solid and in C.W. casing	£40,424	25,848	50 arc, 3 Nernst	77=758 H.P.	60=1,500 H.P.	80,863
..	900	..	Tudor, max. dis. 125 KW. ..	Fdrs. B.I. and Anchor, conc., paper, lead covd., solid, dist. B.I., J. & P. and Anchor, triple conc.	£72,000	25,556	80 arc ..	41=167 H.P.	M.D. 22 KW.	31,812
..	510	368	D. P., max. dis. 150 KW.; Tudor, max. dis. 336 KW.	Callender, fdrs. triple conc., armd., and 2-core solid; dist. 3-core armd. and solid	£108,500	24,367	12 inc. ..	74=770½ H.P.	..	47,518
..	430	192	Niblett, max. dis. 45 KW. ..	Callender, v. bit. and fibre, iron armd.	£37,888	15,000	1 arc, 3 Nernst	28=89 H.P.	..	17,032
..	4,750	2,299	Chloride, 400 amp.-hrs. ..	B.I. & H. and Callender, paper and bit.	£212,579	94,863	69 arc, 100 inc.	77=294 H.P.	..	96,253
..	380	174	Tudor, max. dis. 150 KW. ..	Callender. v. bit., single, wood troughing, solid.. ..	..	8,067	..	21=42½ H.P.	..	10,069
sh	1,224	775	.. ..	V. r. conc., ppr., Callender, Glover and B.I. & H. ..	£83,014	50,553	70 arc, 241 inc. cols.	145 H.P. ..	..	55,370
..	210	120	.. ..	J. & P., twin, solid	..	4,000	..	..	..	4,746
..	1,150	660	.. ..	B.I & H. and Siemens, conc., ppr., lead covd.	£92,200	45,190	60 arc, 170 inc	36=130 H.P.	..	58,000
1	535	250	E. P. S.	Bare cpr., and Callender in ducts and solid	£56,892	18,000	..	14=55 H.P.	..	19,400
..	1,235	610	Tudor, max. dis. 15 KW. ..	Glover, paper, diatrine	£131,832	33,443	104 arc, 103 inc.	10=32 H.P...	..	36,000
..	380	200	D. P., max. dis. 50 KW. ..	Callender, vulc. bit. single, laid solid in wood trough ..	£47,000	15,317	14 arc, 110 inc.	44=141 H.P.	..	16,417
..	460	..	Chloride, 500 amp.-hrs. ..	Callender, single, laid solid	..	..	10 arc, 150 inc.	..	..	..
..	650	497	Tudor, max. dis. 100 KW.; Chloride, max. dis. 150 KW.	Henley, fdrs. tri. conc. solid: dist. 3 single, solid ..	£20,000	7,420	10 arc, 127 inc., 3 Nernst	116 H.P. ..	275 KW. ..	20,033
..	450	158	Chloride, max. dis. 50 KW. ..	Silvertown, v. r. in bit., solid, single	£25,299	9,076	..	17=49¾ H.P...	..	10,900
..	120	41	Marquand, 300 amp.-hrs. ..	V. bit. and ppr., lead covd., solid	£15,000	3,330	4 arc.. ..	13=64 H.P...	..	5,000
..	300	144	Hart, max. dis. 38 KW. ..	Callender, fdrs. tri. conc., armd.; dist. 3-core, armd. laid direct	..	4,641	..	..	..	5,103
..	830	380	Tudor, max. dis. 120 KW. ..	Callender. fdrs. tri. conc., dist. 3-core, all armd. direct	£84,694	20,398	11 arc, 267 inc.	303 H.P. ..	..	31,930
..	600	310	E. P. S., max. dis. 250 KW. ..	Siemens, triple conc., ppr., lead covd. armd. & laid solid	£73,335	25,059	50 arc. ..	8=7 H.P. ..	..	26,289
..	1,383	798	Tudor, max. dis. 40 KW. ..	Bare cpr. in ducts, insd. cable in iron pipes	£147,714	69,882	..	50=141 K.W.	..	77,366
..	375	198	Chloride, 300 amp.-hrs. ..	Callender, fibre, conc. lead covd., solid	£43,000	22,264	688=8 c. p.	5=5½ H.P. ..	..	24,336
..	3,290	1,564	.. ..	B.I. & H. armd. conc., and Glover fdrs., conc. armd. dist., in troughs	£167,568	117,039	38 arc, 48 inc.	128=429 H.P.	..	132,582
..	4,454	3,090	Pritchetts, 438 KW. hrs. ..	Siemens, Callender, fdrs.. conc., jute sheathed; dist. v. bit., lead covd. and armd., and Crompton	£282,910	160,950	12 arc, 20 Nernst	340=2280 H.P.	..	217,917
..	1,600	Ltg. 832, tr. 250	E. P. S., max. dis. 100 KW. ..	Henley, conc. paper, lead covd., armd.	£110,000	42,324	44 arc, 807 inc	43=271 H.P.	44=1,100 H.P.	78,272
..	..	..	.. ..	Callender, laid solid	..	..	..	..	..	..
..	21	21	D. P., max. dis. 15 KW. for 9 hrs.	Callender, fdrs., tri. conc., dist. 3-core., armd., direct ..	£6,000	1,800	33 inc. ..	4=15 H.P. ..	..	2,332
..	330	..	Tudor, 400 amp.-hrs... ..	Johnson & Phillips, ppr., lead covd., solid in wood ..	£69,900	11,021	..	52=25 H.P.	..	50,021
..	300	66	420 amp.-hrs., 280 amp. max.	Fdrs. triple conc., dist. 3-core, solid	..	3,069	..	8=17 H.P. ..	..	3,500
..	440	120	Tudor, 35 KW. for 10 hrs. ..	Callender, jute, lead covd., & vulc. bit., single, solid ..	£48,621	6,969	12 arc, 24 inc., 42 Nernst	50=172 H.P.	16=592 ..	30,477
..	72	64	Tudor, max. dis. 90 amp. for ½ hr.	B.I. & H., triple conc., 2 and 3-core	£12,751	4,708	..	..	..	4,708
..	60	..	.. ..	V. r. underground and overhead	..	..	..	..	..	..
..	480	..	E. P. S., 360 amp.-hrs. ..	Glover, ppr. ins., lead covd., conc.	..	..	30 arc, 60 inc.	..	..	..
..	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	B.I. & H., armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid	..	..	..	..	..	..
..	160	82	.. ..	Callender, armd. conc. fdrs., lead covd. conc. dist. ..	..	3,200	3 inc. ..	..	..	..
..	520	290	Chloride, 157 KW. max. dis...	Siemens, Callender, B.I.H., triple conc.	£45,081	14,430	22 arc, 450 inc., 24 Nernst	37=174 H.P.	..	21,119
..	1,090	175 lg., 300 tr.	Tudor, max. dis. 184 KW. ..	Henley, single lead covd., ppr., solid in wood	£50,000	4,050	104 arc, 208 Nernst	..	44=1232 H.P.	36,800
..	660	425	.. ..	Siemens, Glover, Henley, B.I. & H., armd. conc. laid direct	£80,468	27,903	75 arc, 150 inc., 9 Nernst	8=30 H.P...	..	30,378
st-	1,200	660	.. ..	Callender	£55,195	31,640	34 arc, 68 inc.	46=100 H.P.	..	34,780
..	150	64	.. ..	B.I. & H. fdrs. conc., paper; dist. bare copper, overhead	..	2,295	14 arc, 125 inc.	1=16 H.P.	..	3,003
C.	590	204	E. P. S., max. dis. 290 KW. ..	Callender, jute, lead covd., fdrs. armd., dist. bit. solid..	..	16,000	..	46.5 H.P. ..	..	17,160
..	80	37	Tudor, 72 KW. for 3 hrs. ..	Glover, laid solid, Howard troughing	£14,894	4,183	..	..	..	4,183
..	8,740	5,040	.. ..	B.I. & H., Henley and Silvertown, paper	£752,509	233,172	122 arc ..	636=2,903 H.P.	..	307,849
..	3,400	2,036	.. ..	B.I. & H., paper conc.	£232,931	136,817	..	72=192 H.P.	..	158,721
..	410	270	Chloride, max. dis. 140 KW.	B.I. & H., Johnson & Phillips, and Anchor Cable Co., triple conc., lead covd., solid, and diat.	£22,000	13,247	..	650 H.P	..	89,497
..	1,600	925	E. P. S., max. dis. 300 KW. ..	Triple conc., ppr., direct with steel plates, and solid in wood, B.I. & H.	£70,000	44,960	278 arc 3 Nernst	190=1,208¼ H.P.	..	82,682
..	210	84	Hart, max. dis. 14 KW. ..	Western Electric, fdrs. tri. conc., paper, dist. 3-core ..	£22,677	5,237	..	5=18½ H.P.	..	5,922
..	1,572	854	Tudor, max. dis. 250 KW. ..	Armd. conc., also lead covd. in ducts for dist.	£140,000	47,004	960 arc, 2,081 inc.	12=64 H.P.	..	51,689
..	240	35	.. ..	Bare copper, overhead	..	1,000	..	..	..	..
..	..	..	.. ..	Fdrs. conc., dist. single, laid solid..	..	..	..	..	..	..
..	1,018	372	Chloride, 300 amp.-hrs. ..	Callender, fdrs., conc., armd., dist., conc. and triple conc., v. bit. armd.	£35,550	25,460	30 arc, 60 inc., 33 Nernst	40=90½ H.P.	..	28,365
..	21,695	12,600	E. P. S.	Callender solid..	£1,553,809	438,192	189 arc, 28 inc.	1,111=4,234 H.P.	..	525,812
..	435	264	E. P. S., max. dis. 116 KW. ..	Callender, fdrs. 3 wire, dist. 2 wire, solid	£45,883	27,136	8 inc., 9 Nernst.	3=5 H.P. ..	..	27,216
..	50	..	.. ..	Glover, lead covd. and armd. direct	..	..	..	..	..	..
1	260	..	.. ..	Glover conc. and single, B.I. & Helsby 2-core, armd. direct	..	..	..	..	..	..
..	700	460	Pritchetts & Gold, max. dis. 26 KW.	Henley, Glover, and B. I. & H., triple conc. fdrs., 3-core dist. armd., lead cov., direct	£39,110	21,364	48 arc ..	12=75 H.P.	..	24,593
..	180 700;	101	E. P. S. max. dis. 670 KW.	W. E. Co., paper, lead covd., conc., fdrs. conduit, dist. solid	£19,786	..	183 arc ..	..	..	2,760
..	200	192	.. ..	B.I. & H., lead covd., fdrs. tri. conc., solid; dist., tri. conc., armd. direct	£16,800	9,672	..	11=24 H.P.	..	11,177
..	300	69	Chloride 40 KW. for 18 hrs. ..	Callender, vulc. bitumen, solid	£21,310	4,122	..	25=40 H.P.	..	5,178
..	1,475	550	.. ..	Callender fdrs. armd., dist. v. bit laid solid	£55,000	20,720	70 arc 232 inc.	13=46 H.P.	..	23,496
..	297	128	Chloride, 400 amp.-hrs. ..	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core Dialite v. b.	£28,103	6,737	10 arc, 27 inc.	11=38 H.P.	..	7,890
..	124	69	D. P., max. dis. 22 KW. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£29,318	5,747	2 arc, 109 inc.	12=12 H.P.	..	8,588
..	150	60	.. ..	Fdrs. 2-core, paper, dist. single, paper, Glover & Callender	£8,000	2,366	1 arc, 86 inc.	..	..	2,540
..	150	47	.. ..	Glover conc. lead covd. and armd...	..	2,009	87 inc. ..	..	..	2,327
				Callender, single, solid in iron tray	£50,000	20,090	46 arc, 180	235 H.P. ..	..	27,180

54,805	..	Lg. 7., 4., & 2., or 6., pr. 7. & 1.	Max. demand & flat rate	745,510	4.5	1.93	2.54	2,750 V., D.C. feeders. Supply to Sandgate and Hythe	107
6,300	2½	Lg. 6½., pr. 1. pb. lg contract	Flat rate ..	..	..	..	..	.. ..	108
4,000	..	Lg. 5., pr. 3. ..	Flat rate ..	68,641	4½	1½	3	Water chief source of supply .. .	109
..	..	Lg. 7. & 2½., pr. 4. & 1½.	Max. demand & 2-rate meter	..	..	..	..	Lg. and tr.	110
10,100	30	Lg. 7. & 2. or 4½., pb. lg. 2½., pr. 1½.	Max. demand & flat rate	117,976	..	..	..	.. ..	111
630,708	28.35	Lg. 6. & 1. or 3½., pb. lg. arc £14 p.a. pr. 1½. to ¾. m.d.	Max. demand, flat rate & contract	11,501,224	2.65	.88	1.06	Three stations	112
..	..	Lg. 7. & 4., pr. 4. & 1½.	Max. demand	..	..	..	..	.. ..	113
22,000	..	Lg. 6. & 2., pr. 3. & 1½.	Max. demand	..	..	..	..	.. ..	114
11,801	..	Lg. 7. & 4. or 6., pr. 4 & 1½, htg. 2½.	Max. demand, flat, contract	148,592	3.74	1.9	1.75	.. ..	115
1,320	14	6. & 4., or 1 3 per c.p. p.a.	Max. demand or contract	..	..	..	..	.. ..	116
42,975	..	Lg. 6. & 1. or 4., 3½. & 3., £17 arc, pr. 2—1.	Max. demand contract, scale	896,160	2.16	.672	1.03	Data to Mar. 15th, 1904, units to May, 1904	117
18,730	..	Lg. 7. & 3., pr. 4. & 1. or 2½.	Max. demand & flat rate	119,784*	4.1	.88	1.17	Small houses free-wired, 7d. p. u. slot meter. *10 months only	118
..	..	Lg. 7. & 3., pr. 3. ..	Max. demand	..	..	..	..	Lighting and traction (Gravesend and Northfleet Tramway Co.).	119
7,695	33	Lg. 7. & 4., pr. 2½., pb. lg. 3½.	Max. demand, flat & contract	138,830	4.33	1.83	2.63	.. ..	120
80,863	16.8	Lg. 6. & 2. or 4½., pr. 2½. to 1½., tr. 1¼.	Max. demand, flat & scale	1,263,972	2.3	1.01	1.31	Traction supply (250 KW.) to G. & Port Glasgow Ty. Co. over 500,000 units 7-10d.	121
31,812	..	Lg. 4½., pr. 2½. to 1½. & 1 t. sw., tr. 1½. to 1¼.	Flat rate, cont., scale & t. sw.	653,438	2.51	.99	1.4	Energy supplied to Tramway Co. Pb. lg. arc £20 p.a.	122
47,518	63.2	Lg. 7. & 3. or 6., pr. 4. & 1½. or 2½., htg. 2.	Max. demand & flat	434,958	2.97	1.59	1.97	Data to Dec. 1903. New station nearly completed. Pb. lg. inc. £2½ p.a.	123
17,032	70	Lg. 7., pr. 3. to 2., pb. lg. 3.	Flat rate & scale	145,891	6.1*	2.6	3.48	*includes meter rents	124
96,253	15	Lg. 4. & 3., pb. lg. 3., pr. 2—1., tr. 1½.	Flat rate & scale	3,690,713	2.19	.92	1.21	Lg and tr.	125
10,069	..	Lg. 7. & 3., pr. 2. & 1.	Max. demand & flat	85,338‡	4.1	..	..	*4d. flat rate after Oct. 31st, 1904. ‡For 10 months	126
55,370	..	Lg. 6. & 3., pr. 3. & 1., pb. lg. £22 & £3½	Max. demand	812,038	4.49	1.59	2.04	.. ..	127
4,746	38	3½.	Flat rate ..	100,000	3.5	1.25	2.5	.. ..	128
58,000	..	Lg. 6., 4., 3. or 6. & 2., pr. 2.	Max. demand & flat rate	761,136	4.75	1.30	1.91	Price 6d. and 2d. over 15,000 units ..	129
19,400	..	Lg. 8. & 4., pr. 4.	Max. demand & flat rate	..	..	..	..	.. ..	130
36,000	..	Lg. & pr. 6d., or 10s. p.a. per lp. & 1½. p.u.	Flat rate & Hopkinson	852,094	4.58	2.07	2.58	* Pb. lg. £3½ per KW. & 1½d. per unit..	131
16,417	..	Lg. 5. to 3., pr. 2½. to 1½.	Max. demand & flat	178,815	3.3	.91	1.23	200 KW. extns. in hand	132
..	..	Lg. 4. to 4½., pr. 2. to 1½.	Flat rate & sliding scale	..	..	..	..	.. ..	133
20,033	..	Lg. 5., pr. 1. & 2., tr. 2. w. dis.	Flat rate w. dis.	257,084	2.57	.84	1.23	Lg and tr. Pb. lg. £12½, £3 & £1½ ..	134
10,900	..	Lg. 6. & 4., pr. 3. & 2.	Max. demand	128,100	4.75	1.48	2.31	Auxiliaries driven by electric motors ..	135
5,000	..	Lg. 6. & 3., pr. 2½. & 1½.	Accdg. to lps. installed ..	39,679	4.23	..	4.31	.. ..	136
5,103	40.6	Lg. 7. & 2. and 8. & 2*., pr. 4½ & 1½	Max. demand & sl. scale	125,745	4.28	..	3.56	* With free wiring	137
31,930	13	Lg. 5. & 2., pr. 2½. or 4. & 1.	Max. demand	470,164	3.33	1.26	1.7	Traction under consideration. Pb. lg. £16 and £3½	138
26,289	..	Lg. 7. & 2. or 5., pr. 2½., pb. lg. 3.	Max. demand & flat rate	341,230	..	..	..	.. ..	139
77,366	7.44	Lg. 7. & 4., pr. 3. & 2.	Max. demand	779,985	5.48*	1.85*	1.4	Data to Dec. '03. * Previous year ..	140
24,336	30	Lg. 7. & 3. or 5½. pr., 3. & 1½., pb. lg. 3½.	Max. demand & flat rate	225,201	4.5	..	..	25 KW. motor alternator for charging batteries and taking day load. Data to 31/3/04	141
132,582	17	Lg. 4½., pr. 2½. & 1., pb. lg. £17½ & 33s. p.a.	Flat rate ..	1,559,960	3.65	.96	1.32	.. ..	142
217,917	13.1	Lg. 5. & 2. or 4½., pr. 2. to 1. or 2*	Max. demand fl. r. & scale	3,017,188	2.91	1.17	1.56	* Pb. lg. £22	143
78,272	..	Lg. 8. & 2. or 5., pr. 3. to 1½, tr. 1½.*	Max. demand & flat rate	1,639,184	..	1.095	1.437	Lg. and tr. * Pb. lg. £18 & £4.25 ..	144
..	..	Lg. 4½., pr. 3. ..	Flat rate ..	..	..	..	..	.. ..	145
2,332	..	Lg. 6., pr. 3., htg. 1., pb. lg. 2.9	Flat rate and contract	17,422	4.78	3.08	..	Heavy costs due to Battery renewals ..	146
50,021	..	Lg. 6., pr. 2., tr. 2.	Flat rate & scale with dis.	..	..	..	..	.. ..	147
3,500	..	Lg. 7. & 1., pr. 4. & 1½.	Max. demand	..	..	..	..	.. ..	148
30,477	223	Lg. 7. & 3. or 5., pr. 2½. to 1½., pb. lg. 3., tr. 2.	Max. demand & flat rate	187,721	3.66	1.49	3.22	* Traction motors connected in August, 1904. Data to June 30, 1903	149
4,708	47.1	Lg. 6., pr. 3. ..	Flat rate ..	31,475	6.04	3.5	5.9	.. ..	150
..	..	6.	Flat rate ..	..	..	..	..	* Management in the hands of the Windermere Co.	151
..	..	Lg. 4½., pr. 2. to 1½.	Flat rate ..	..	..	..	..	Opened May, 1904..	152
..	..	Lg. 7. & 2½., pr. 4½. & 1½.	Max. demand with dis.	343,594	..	1.44	..	Lg. and tr.	153
..	..	5.	Contract & flat rate	..	..	..	..	.. ..	154
21,119	21	Lg. 5., 4½., 4½.*, pr. 3. & 1½., pb. lg. 2.32.	Fl. r., cont., m. d., T. R. mtr.	388,472	3.12	1.085	1.439	* Contract. Tr. 1¼d. & 1½d.	155
36,800	..	Lg. 4½., pr. 2½., pb. lg. £16 arc p.a., tr. 2	Flat rate with rebates	..	..	..	..	Lg. and tr.	156
30,378	12	Lg. 7. & 3., pr. 3. to 2., pb. lg. 3.1	Max. demand	460,628	5.211	2.058	2.625	.. ..	157
34,780	..	Lg. 5., pr. 3. ..	Flat rate ..	398,960	4.30	1.87	2.41	.. ..	158
3,003	..	Lg. from 1½., pb. lg. £2.6 p. 16 c.p.p.a.	Contract & meters	..	..	..	..	.. ..	159
17,160	..	Lg. 7. & 3½. or 6., pr. 4., htg. 3½.	M. d., Hop. & flat rate*	169,313	..	..	..	* Also 2-rate meters used. 1 McLaren engine & 1 E.C.C. altr. on order	160
4,183	70	Lg. 7. to 4.*, pr. 4.	Flat rate & sl. scale	27,066	5.75	4	5 75	* 7d. for first 14 units per 8 c.p.p.a. and 4d. after	161
307,849	32.8	Lg. 4., pr. 2. to 1½., less 5%	Lg. flat rate, pr. max. dem.	6,271,186	2.90	.65	.97	No meter rents. * Also 50—, 1-ph. ..	162
158,721	22	Lg. 4., pr. 2. ..	Flat rate ..	1,719,001	3.82	0.12	1.78	.. ..	163
89,497	..	Ltg. 7. & 2½. or 5., pr. 3. & ¾.	Max.dem., flat rate & scale	460,805	2.4	1.012	1.251	.. ..	164
82,682	25.03	Ltg. 4., pr. 1½., pb. lg. £19	Flat rate with dis.	..	..	..	..	.. ..	165
5,922	28	Lg. 7. & 2½. or 5., pr. 4½. & 1½. or 2½.	Max. demand & flat rate	68,106	4.9	2.48	4.62	.. ..	166
51,689	17.5	Lg. 5. & 2., pr. 5. & 1.	Max. demand	1,193,785	3.4	1.21	1.624	Pb. lg. £21 per arc & £4.175 inc. ..	167
..	..	10s. per 8 c.p. ..	Contract ..	..	..	..	..	.. ..	168
..	..	Lg. 5., pr. 2. ..	Flat rate ..	..	..	..	..	.. ..	169
28,365	20.4	Pb. & prvt. lg. 6. & 2½., pr. 4. & 1., or 2½.	Max. dem. w dis.. & flat r.	399,797	3.7	1.088	1.598	.. ..	170
525,812	19	Lg. 3½. & 3., pr. 2. & 1½., pb. lg. 2., tr. 1.05.*	Sliding scale & flat rate	26,015,062	1.835	.678	.911	Lg. and tr. Data to Dec. 31, 1903. *Plus 5% for every 1s. paid above 6s. for coal	171
27,216	28½	Lg. 5., pr. 3., pb. lg. 5. less 33⅓%	Flat rate ..	187,171	4.88	1.48	2.75	* Gt. Crosby and Waterloo	172
..	..	Lg. 6., pr. 4. ..	Flat rate ..	..	..	..	..	.. ..	173
..	..	Lg. 6., pr. 6. to 3½.	Flat rate and scale	..	..	..	..	.. ..	174
24,593	13.48	Lg. 7. & 2½. or 5½., pr. 2., pb. lg. 1.75	Max. dem., flat & contract	341,870	3.82	1.61	2.02	Max. load in summer	175
2,760	..	..	..	288,647*	..	1.6	2.27	* Public lg. only. ‡ Private supply to commence this summer (1904), 700 KW.	176
11,177	..	Lg. 6. & 3., pr. 2½ to 1½., pb. lg. 2.	Max. demand, scale & cont.	242,734	2.78	1.08	1.40	Results for period since commencement of supply, Jan. 8, '03, to Mar. 31, '04	177
5,178	19	Lg. 8. & 2., pr. 2½., tr. 1½.	Max. demand	61,823	4.4	1.4	1.8	.. ..	178
23,496	..	Lg. 7. & 3, pr. & tr. 2½, pb. lg. £16 & £2.9	Max. dem. scle. and contract	587,423	5	1.75	2.20	.. ..	179
7,890	..	Lg. 6. & 3., or 4½., pr. 2. & 1½.	Max. demand & flat rate	92,690	4.06	1.57	2.71	.. ..	180
8,588	..	Lg. 7. & 4. or 6. pr. 4. & 2½, pb. lg. £2.25 p.a.	Max. demand & flat	74,596	4.84	..	3.2	.. ..	181
2,540	13	Lg. 5., pb. lg. £3 p.a.	Flat rate & contract	91,442	..	..	..	.. ..	182
2,327	..	4½., 1s. per c.p.p.a., pb. lg. cont.	Flat rate & contract	..	..	..	..	.. ..	183
27,180	..	Lg. 7. & 2., or 5 (shop), 4½., pr. 2., pb. lg. 1.75	Max. demand, flat, scale	493,400	3.26	1.636	2.496	Supply to tramways later	184

	2,827	..	4½., 1s. per c.p.p.a.; pb. lg. cont.		493,400	3.26	1.636	2.496	Supply to tramways later				184
	27,180	..	Lg. 7. & 2., or 5 (shop),	Max. demand,									

.. ..	2 Johnson & Phillips	72	64	Tudor, max. dis. 90 amp. for ½ hr.	B.I. & H., triple conc., 2 and 3-core	£12,751	4,708	..	
..se, 1 Victor turbine ..	2 Kapp	60	..	.. ..	V. r. underground and overhead	..	..	..	
.. ..	4 Parker	480	..	E. P. S., 360 amp.-hrs.	Glover, ppr. ins., lead covd., conc.	..	..	30 arc, 60 inc.	
2 Parsons turbines ..	3 Mordey, 2 Parsons	1,050	..	Chloride, & Pollak, 750 amp.-hrs.	B.I. & H., armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid	..	..	..	
, 1 turbine, 1 water-wheel ..	2 Mordey, 1 Ferranti	160	82	.. ..	Callender, armd. conc. fdrs., lead covd. conc. dist. ..	..	3,200	3 inc. ..	
(steam), 5 Fielding & Platt	2 Laurence Scott, 5 G. E. C.	520	290	Chloride, 157 KW. max. dis.	Siemens, Callender, B.I.H., triple conc.	£45,081	14,430	22 arc, 450 inc., 24 Nernst	
t-Lindley	8 Laurence Scott	1,090	175 lg., 300 tr.	Tudor, max. dis. 184 KW.	Henley, single lead covd., ppr., solid in wood	£50,000	4,050	104 arc, 208 Nernst	
s	11 Siemens	660	425	.. ..	Siemens, Glover, Henley, B.I. & H., armd. conc. laid direct	£86,468	27,903	75 arc, 150 inc., 9 Nernst	
s, 1 Westinghouse, 4 Belliss	3 Brush, 1 Mather & Platt, 5 Westinghouse	1,200	660	.. ..	Callender	£55,195	31,640	34 arc, 68 inc.	
Barbour, 1 Belliss	2 Brush, 1 B.T.H.	150	64	.. ..	B.I. & H. fdrs. conc., paper; dist. bare copper, overhead	..	2,295	14 arc, 125 inc.	
1 Belliss	5 Chamberlain & Hookham, 1 E.C.C.	590	204	E. P. S., max. dis. 290 KW.	Callender, jute, lead covd., fdrs. armd., dist. bit. solid.	..	16,000	..	
hall-Rossiter"	2 Lancs. D. & M. Co.	80	37	Tudor, 72 KW. for 3 hrs.	Glover, laid solid, Howard troughing	£14,894	4,183	..	
r, 2 Hick-Hargreaves, 12 , 1 McLaren Hargreaves	4 Ferranti, 9 E. C. C., 3 Fowler ..	8,740	5,040	.. ..	B.I. & H., Henley and Silvertown, paper	£752,509	233,172	122 arc ..	63
	4 Ganz, 2 Brush	3,400	2,036	.. ..	B.I. & H., paper conc.	£232,931	136,817	..	7
s, 1 Galloway, 1 Mather & h's.	5 Mather & Platt	416	270	Chloride, max. dis. 140 KW.	B.I. & H., Johnson & Phillips, and Anchor Cable Co., triple conc., lead covd., solid, and dist.	£22,000	13,247	..	
, 2 Howden	7 Silvertown, 2 Crompton	1,600	925	E. P. S., max. dis. 300 KW.	Triple conc., ppr., direct with steel plates, and solid in wood, B.I. & H.	£70,000	44,960	278 arc 3 Nernst	19
1 Allen	3 Brush	210	84	Hart, max. dis. 14 KW.	Western Electric, fdrs. tri. conc., paper, dist. 3-core ..	£22,677	5,237	..	5
s	5 Mather & Platt, 1 A. E. G. ..	1,572	854	Tudor, max. dis. 250 KW.	Armd. conc., also lead covd. in ducts for dist.	£140,000	47,004	960 arc. 2,081 inc.	12
.. ..	4 Siemens	240	35	.. ..	Bare copper, overhead	..	1,000	..	
ghouse gas engines	3 A. E. G.	..	..	.. ..	Fdrs. conc., dist. single, laid solid.	..	..	..	
s, 1 Howden	7 Laurence Scott, 1 Bruce Peebles ..	1,018	372	Chloride, 300 amp.-hrs.	Callender, fdrs., conc., armd., dist., conc. and triple conc., v. bit. armd.	£35,350	25,460	30 arc, 60 inc., 33 Nernst	40
ns	75 Siemens	21,695	12,600	E. P. S.	Callender solid.	£1,553,809	438,192	189 arc, 28 inc.	1,1
s, 2 Browett-Lindley ..	4 Parker, 1 Siemens, 1 Robinson ..	435	264	E. P. S., max. dis. 116 KW.	Callender, fdrs. 3 wire, dist. 2 wire, solid	£45,983	27,136	8 inc.. 9 Nernst.	3
t-Lindley	1 Bertram Thomas	50	..	.. ..	Glover, lead covd. and armd. direct	..	..	..	
s, 1 Alley & MacLellan, 1 ll	1 Siemens, 1 Mather & Platt, 1 Bertram Thomas	260	..	.. ..	Glover conc. and single, B.I. & Helsby 2-core, armd. direct	..	..	..	
, 3 Allen	4 Silvertown, 2 Crompton	700	460	Pritchetts & Gold, max. 26 KW.	Henley, Glover, and B. I. & H., triple conc. fdrs., 3-core dist. armd., lead cov., direct	£39,110	21,364	48 arc ..	12=7
& Sons, 4 Allen‡	6 Siemens arc, 4 B. T. H.‡	180 700‡	101	E. P. S. max. dis. 670 KW.	W. E. Co., paper, lead covd., conc., fdrs. conduit, dist. solid	£19,786	..	183 arc ..	
t-Lindley	4 Lancs. D. & M. Co.	200	192	.. ..	B.I. & H., lead covd., fdrs. tri. conc., solid; dist., tri. conc., armd. direct	£16,800	9,672	..	11=2
.. ..	2 E. C. C.	300	69	Chloride 40 KW. for 18 hr	Callender, vulc. bitumen, solid	£21,310	4,122	..	25=40
ave, 7 Browett-Lindley, 5 s	12 B. T. H., 3 Lanc. Dynamo Co. ..	1,475	550	.. ..	Callender fdrs. armd., dist. v. bit laid solid	£55,000	20,720	70 arc 232 inc.	13=46
.. ..	5 Allen	297	128	Chloride, 400 amp.-hrs.	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core Dialite v. b.	£28,103	6,737	10 arc, 27 inc.	11=38
.. ..	2 Parker	124	69	D. P., max. dis. 22 KW.	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£29,318	5,747	2 arc, 109 inc.	12=12
an (steam), 1 Escher Wyss, (water) turbine, 1 water wheel, 1	2 Brush, 1 E. C. C.	150	60	.. ..	Fdrs. 2-core, paper, dist. single, paper, Glover & Callender	£8,000	2,366	1 arc, 86 inc.	..
.. ..	1 B. T. H., 1 Brush, 1 Ediswan ..	150	47	.. ..	Glover conc. lead covd. and armd.	..	2,009	87 inc. ..	..
.. ..	3 Parker, 2 Westinghouse	750	351	Chloride, max. dis. 150 KW	Callender, single, solid in iron trg.	£50,000	20,090	46 arc. 180 Nernst	235 H.P.
way, 5 Goodfellow, 2 Mus- 2 Ferranti, 2 Parsons turbo. ave	6 Mather & Platt, 4 E. C. C., 1 Siemens, 2 Westinghouse, 2 Parsons	10,350							
	4 Westinghouse	7,200	12,115	Chloride, 480 KW.-hrs.	Bare copper, v. r., ppr., and v. bit., Callender, B.I. & H., Glover, Western Electric, Johnson & Phillips	£1,791,000	398,659	29 arc ..	1,025=3,3 H.P.
& Thom, 2 Wallsend Slip- Willans & MacLellan	11 Electrical Co. (A. E. G.)	16,000*							
phase	2 Parker .. .. sub-stations	480	127	Tudor, max. dis. 100 KW.	Western Electric, triple conc. ppr. lead covd., laid solid in c'ware and iron trough	£60,000	5,000	30 arc ..	20
		300	90	Tudor, max. dis. 25 KW.	Callender, triple conc.	..	..	60 arc ..	..
.. ..	2 Parker	90	58	Pritchetts, 400 amp.-hrs.	Callender, fdrs. tri. conc. armd. b. fibre, ld. covd., dist. 3-core lead covd. and armd., direct	£12,912	4,091	..	14=50 H.P.
s turbines	3 Parsons	300	118.4	D. P., max. dis. 160 KW.	Callender, lead covd. steel taped, tri. conc. fdrs., 3-core dist.	£35,253	8,880	5 arc, 177 inc.	26=58 H.P.
t Lindley	3 Peebles, 1 Silvertown	630	408	Hart, lg. 250 a.-h., Chl tr. 240 a.-h.	Callender, triple conc. dist., fdr. in C. I. pipes, Al armd., 3-core	£37,700	..	1 arc, 2 inc.	3=7½ H.P.

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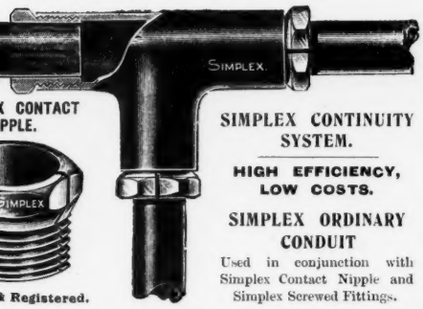

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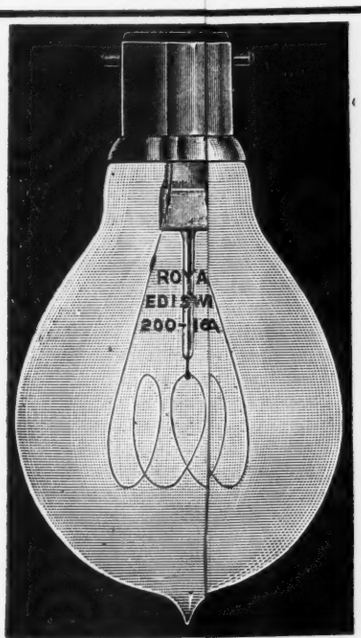

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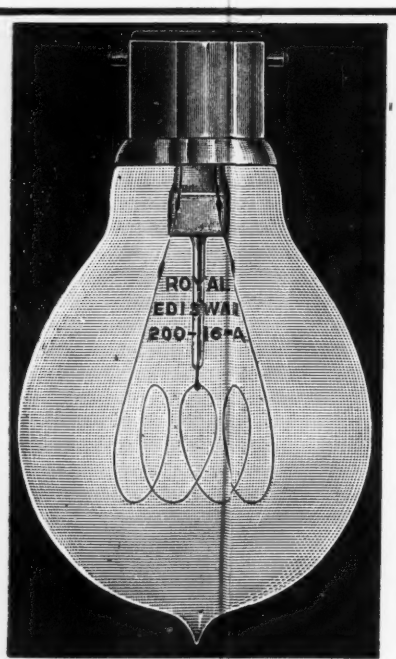
LONDON, E.C.

Contractors to H.M. Government.

72	64	Tudor, max. dis. 90 amp. for ½ hr.	B.I. & H., triple conc., 2 and 3-core	£12,751	4,708	42 Nernst ..	..	..		4,708
60	..	.. ..	V. r. underground and overhead	..	..	..	..	..		..
480	..	E. P. S., 360 amp.-hrs. ..	Glover, ppr. ins., lead covd., conc.	..	..	30 arc, 60 inc.	..	..		..
,050	..	Chloride, & Pollak, 750 amp.-hrs.	B.I. & H., armd., lead covd., conc.; sep. power cables, 3-core lead covd., solid	..	..	..	..	..		..
160	82	.. ..	Callender, armd. conc. fdrs., lead covd. conc. dist. ..	..	3,200	3 inc. ..	..	..		..
520	290	Chloride, 157 KW. max. dis...	Siemens, Callender, B.I.H., triple conc.	£45,081	14,430	22 arc, 450 inc., 24 Nernst	37=174 H.P.	..		21,119
,090	175 lg., 300 tr.	Tudor, max. dis. 184 KW. ..	Henley, single lead covd., ppr., solid in wood	£50,000	4,050	104 arc, 208 Nernst	..	44=1232 H.P.		36,800
660	425	.. ..	Siemens, Glover, Henley, B.I. & H., armd. conc. laid direct	£86,468	27,903	75 arc, 150 inc., 9 Nernst	8=30 H.P...	..		30,378
,200	680	.. ..	Callender	£55,195	31,640	34 arc, 68 inc.	46=100 H.P.	..		34,780
150	64	.. ..	B.I. & H. fdrs. conc., paper; dist. bare copper, overhead	..	2,295	14 arc, 125 inc.	1=16 H.P.	..		3,003
590	204	E. P. S., max. dis. 290 KW. ..	Callender, jute, lead covd., fdrs. armd., dist. bit. solid..	..	16,000	..	46.5 H.P. ..	..		17,160
80	37	Tudor, 72 KW. for 3 hrs. ..	Glover, laid solid, Howard troughing	£14,894	4,183	..	..	..		4,183
,740	5,040	.. ..	B.I. & H., Henley and Silvertown, paper	£752,509	233,172	122 arc ..	636=2,903 H.P.	..		307,849
,400	2,036	.. ..	B.I. & H., paper conc.	£232,931	136,817	..	72=192 H.P.	..		158,721
410	270	Chloride, max. dis. 140 KW...	B.I. & H., Johnson & Phillips, and Anchor Cable Co., triple conc., lead covd., solid, and diat.	£22,000	13,247	..	650 H.P	..		89,497
,600	925	E. P. S., max. dis. 300 KW. ..	Triple conc., ppr., direct with steel plates, and solid in wood, B.I. & H.	£70,000	44,960	278 arc 3 Nernst	190=1,203¼ H.P.	..		82,682
210	94	Hart, max. dis. 14 KW. ..	Western Electric, fdrs. tri. conc., paper, dist. 3-core ..	£22,677	5,237	..	5=18½ H.P.	..		5,922
,572	854	Tudor, max. dis. 250 KW. ..	Armd. conc., also lead covd. in ducts for dist.	£140,000	47,004	960 arc, 2,081 inc.	12=64 H.P.	..		51,689
240	35	.. ..	Bare copper, overhead	..	1,000	..	..	..		..
..	..	.. ..	Fdrs. conc., dist. single, laid solid..	..	..	..	..	..		..
,018	372	Chloride, 300 amp.-hrs. ..	Callender, fdrs.,, conc., armd., dist., conc. and triple conc., v. bit. armd.	£35,550	25,460	30 arc, 60 inc., 33 Nernst	40=90½ H.P.	..		28,365
,695	12,600	E. P. S...	Callender solid..	£1,553,809	438,192	189 arc, 28 inc.	1,111=4,234 H.P.	..		525,812
435	264	E. P. S., max. dis. 116 KW...	Callender, fdrs. 3 wire, dist. 2 wire, solid	£45,883	27,136	8 inc., 9 Nernst.	3=5 H.P. ..	..		27,216
50	..	.. ..	Glover, lead covd. and armd. direct	..	..	..	..	..		..
260	..	.. ..	Glover conc. and single, B.I. & Helsby 2-core, armd. direct	..	..	..	..	..		..
700	460	Pritchetts & Gold, max. dis. 26 KW.	Henley, Glover, and B. I. & H., triple conc. fdrs., 3-core dist. armd., lead cov., direct	£39,110	21,364	48 arc ..	12=75 H.P.	..		24,593
180	101	E. P. S. max. dis. 670 KW....	W. E. Co., paper, lead covd., conc., fdrs. conduit, dist. solid	£19,786	..	183 arc ..	..	..		2,760
700										
200	192	.. ..	B.I. & H., lead covd., fdrs. tri. conc., solid: dist., tri. conc., armd. direct	£16,800	9,672	..	11=24 H.P.	..		11,177
300	69	Chloride 40 KW. for 13 hrs...	Callender, vule. bitumen, solid	£21,310	4,122	..	25=40 H.P.	..		5,178
,475	550	.. ..	Callender fdrs. armd., dist. v. bit laid solid	£55,000	20,720	70 arc 232 inc.	13=46 H.P.	..		23,496
297	128	Chloride, 400 amp.-hrs. ..	Callender, v. bit. 3-core dist., conc. fdrs. & sing. core Dialite v. b.	£28,103	6,737	10 arc, 27 inc.	11=38 H.P.	..		7,890
124	69	D. P., max. dis. 22 KW. ..	Callender, triple conc. fdrs., 3-core dist., all armd. ..	£29,318	5,747	2 arc, 109 inc.	12=12 H.P.	..		8,588
150	60	.. ..	Fdrs. 2-core, paper, dist. single, paper, Glover & Callender	£8,000	2,366	1 arc, 86 inc.	..	..		2,540
150	47	.. ..	Glover conc. lead covd. and armd...	..	2,009	87 inc. ..	..	..		2,327
750	351	Chloride, max. dis. 150 KW.	Callender, single, solid in iron trg.	£50,000	20,080	46 arc, 180 Nernst	235 H.P. ..	..		27,180
350										
200	12,115	Chloride, 480 KW.-hrs. ..	Bare copper, v. r., ppr., and v. bit., Callender, B.I. & H., Glover, Western Electric, Johnson & Phillips	£1,791,000	398,659	29 arc ..	1,025=3,298 H.P.	..		481,700
,000*										
460	127	Tudor, max. dis. 103 KW. ..	Western Electric, triple conc. ppr. lead covd., laid solid in c'ware and iron trough	£60,000	5,000	30 arc ..	20	..		9,580
300	90	Tudor, max. dis. 25 KW. ..	Callender, triple conc.	..	..	60 arc ..	..	..		4,850
90	58	Pritchetts, 400 amp.-hrs. ..	Callender, fdrs. tri. conc. armd. b. fibre, ld. covd., dist. 3-core lead covd. and armd., direct	£12,912	4,091	..	14=50 H.P.	..		5,591
300	118.4	D. P., max. dis. 160 KW. ..	Callender, lead covd. steel taped, tri. conc. fdrs., 3-core dist.	£35,253	8,880	5 arc, 177 inc.	26=58 H.P.	..		11,028
630	408	Hart, lg. 250 a.-h., Chloride tr. 240 a.-h.	Callender, triple conc. fibre; fdr. in C. I. pipes, dist., armd., 3-core	£37,793	4,542	1 arc, 2 inc.	3=7½ H.P...	30=1,000 H.P.		29,...6

LONGEST USEFUL LIFE.



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References to
hundreds of
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SEND

			to 1¼., pb. lg. 3., tr. 2.	& flat rate					* Traction motors connected in August, 1904. Data to June 30, 1903	149
	4,708	47.1	Lg. 6., pr. 3. ..	Flat rate ..	31,475	6.04	3.5	5.9	.. ..	150
	..	..	6.	Flat rate ..	..	..	..	..	* Management in the hands of the Windermere Co.	151
	..	..	Lg. 4½., pr. 2. to 1½	Flat rate ..	..	..	..	..	Opened May, 1904..	152
	..	..	Lg. 7. & 2½., pr. 4½. & 1½.	Max. demand with dis.	343,594	..	1.44	..	Lg. and tr.	153
	..	..	5.	Contract & flat rate	..	..	..	..	.. ..	154
	21,119	21	Lg. 5., 4½., 4½.*, pr. 3. & 1½., pb. lg. 2.32.	Fl. r., cont., m. d., T. R. mtr.	388,472	3.12	1.085	1.439	* Contract. Tr. 1¼d. & 1½d.	155
2 H.P.	36,800	..	Lg. 4½., pr. 2½., pb. lg. £16 arc p.a., tr. 2	Flat rate with rebates	..	..	..	..	Lg. and tr.	156
	30,378	12	Lg. 7. & 3., pr. 3. to 2., pb. lg. 3.1	Max. demand	460,628	5.211	2.058	2.625	.. ..	157
	34,780	..	Lg. 5., pr. 3. ..	Flat rate ..	398,960	4.30	1.87	2.41	.. ..	158
	3,003	..	Lg. from 1½., pb. lg. £2.6 p. 16 c.p.p.a.	Contract & meters	..	..	..	..	.. ..	159
	17,160	..	Lg. 7. & 3½. or 6., pr. 4., htg. 3½.	M. d., Hop. & flat rate*	169,313	..	..	..	* Also 2-rate meters used. 1 McLaren engine & 1 E.C.C. altr. on order	160
	4,183	70	Lg. 7. to 4.*, pr. 4.	Flat rate & sl. scale	27,066	5.75	4	5 75	* 7d. for first 14 units per 8 c.p.p.a. and 4d. after	161
	307,849	32.8	Lg. 4., pr. 2. to 1½, less 5%	Lg. flat rate, pr. max. dem.	6,271,186	2.90	.65	.97	No meter rents. * Also 50—, 1-ph. ..	162
	158,721	22	Lg. 4., pr. 2. ..	Flat rate ..	1,719,001	3.82	0.12	1.78	.. ..	163
	89,497	..	Ltg. 7. & 2½. or 5., pr. 3. & ¾.	Max.dem., flat rate & scale	460,305	2.4	1.012	1.251	.. ..	164
	82,682	25.03	Ltg. 4., pr. 1¼., pb. lg. £19	Flat rate with dis.	..	..	..	..	.. ..	165
	5,922	28	Lg. 7. & 2½. or 5., pr. 4½. & 1½. or 2½.	Max. demand & flat rate	68,106	4.9	2.48	4.62	.. ..	166
	51,689	17.5	Lg. 5. & 2., pr. 5. & 1.	Max. demand	1,193,785	3.4	1.21	1.624	Pb. lg. £21 per arc & £4.175 inc. ..	167
	..	..	10s. per 8 c.p. ..	Contract ..	..	..	..	..	.. ..	168
	..	..	Lg. 5., pr. 2. ..	Flat rate ..	..	..	..	..	.. ..	169
	28,365	20.4	Pb. & prvt. lg. 6. & 2½., pr. 4. & 1., or 2½.	Max. dem. w dis.. & flat r.	399,797	3.7	1.088	1.598	.. ..	170
	525,812	19	Lg. 3½. & 3., pr. 2. & 1½., pb.lg. 2., tr. 1.05.*	Sliding scale & flat rate	36,015,062	1.835	.678	.911	Lg. and tr. Data to Dec. 31, 1903. *Plus 5% for every 1s. paid above 6s. for coal	171
	27,216	28½	Lg. 5., pr. 3., pb. lg. 5. less 33⅓%	Flat rate ..	187,171	4.88	1.48	2.75	* Gt. Crosby and Waterloo	172
	..	..	Lg. 6., pr. 4. ..	Flat rate ..	..	..	..	..	.. ..	173
	..	..	Lg. 6., pr. 6. to 3½.	Flat rate and scale	..	..	..	..	.. ..	174
	24,593	13.48	Lg. 7. & 2½. or 5½., pr. 2., pb. lg. 1.75	Max. dem., flat & contract	341,870	3.82	1.61	2,02	Max. load in summer	175
	2,760	..	..	..	283,647	..	1.6	2.27	* Public lg. only. ‡ Private supply to commence this summer (1904), 700 KW.	176
	11,177	..	Lg. 6. & 3., pr. 2½ to 1½., pb. lg. 2.	Max. demand, scale & cont.	242,734	2.78	1.08	1.40	Results for period since commencement of supply, Jan. 8, '03, to Mar. 31, '04	177
	5,178	19	Lg. 8. & 2., pr. 2½., tr. 1½.	Max. demand	61,823	4.4	1.4	1.8	.. ..	178
	23,496	..	Lg. 7. & 3, pr. & tr. 2½, pb. lg. £16 & £2.9	Max. dem. scle. and contract	587,423	5	1.75	2.20	.. ..	179
	7,890	..	Lg. 6. & 3., or 4½., pr. 2. & 1½.	Max. demand & flat rate	92,690	4.06	1.57	2.71	.. ..	180
	8,588	..	Lg. 7. & 4. or 6. pr. 4. & 2½, pb. lg. £2.25 p.a.	Max. demand & flat	74,596	4.84	..	3.2	.. ..	181
	2,540	13	Lg. 5., pb. lg. £3 p.a.	Flat rate & contract	91,442	..	..	..	.. ..	182
	2,327	..	4½., 1s. per c.p.p.a., pb. lg. cont.	Flat rate & contract	..	..	..	..	.. ..	183
	27,180	..	Lg. 7. & 2., or 5 (shop), 4 (house), pb. lg. 1.75, tr. 2 to 1½., pr. 2. to 1.	Max. demand, flat, scale	493,400	3.26	1.636	2.496	Supply to tramways later	184
	481,700	..	Lg. 5½. & 1¾., pr. 2. to 1., sliding scale	Max. demand & sliding scale from 5½d. to 1¾d.	17,378,600	3.48	1.08	1.55	Corporation tramways supplied from Dickinson St., Bloom St., and Stuart St. Works. Plant installed for 800 cars. * 7,500 KW. under constructn.	185
	9,560	..	Lg. 7. & 2., pr. 6. & 1., pb. lg. 2.	Max. demand	144,000*	3.2	1.2	2.4	Lg. and tr. 9 months wkg. figs. approximately	186
	4,850	..	6. & 3., pr. 3. ..	Max. demand & flat rate	..	5	..	..	.. ..	187
	5,591	..	7. & 4., pr. 2½. ..	Max. demand & flat rate	29,236	5	2.4	4	.. ..	188
	11,028	..	Lg. 7. & 4. or 6., pr. 4. & 1½. or 2½.	Max. demand & flat rate	147,013	3.7	1.60	2.18	Pb. lg. 3 years at £335 p.a.	189
0 H.P.	29,156	..	Lg. 7. & 2½., pr. 4½. & 1½., tr. 1½.	Max. demand	426,024	1.95	1.02	1.42	Lg. and tr. Highfield booster	190

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